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CINCINNATI, OHIO VOL. 1, NO 6

MARCH, 1937

# The Silver Plating of Hollow-Ware

BY DR. B. EGEBERG AND N. E. PROMISEL
**International Silver Co., Meriden, Conn.**

AT THE very start, there are certain fundamental differences between hollow-ware and most other articles that may be plated, with the exception perhaps of novelty articles. These differences are based on the composite character so often found in hollow-ware, it being not unusual to find in a final single piece four or five different basis metals soldered together. Besides the problem of simultaneously cleaning and plating this variety of metals existing in electrical inter-connection, there is the situation that the article often cannot be polished all over, after its completed fabrication, but rather must be polished in sections at certain stages, which sections may later be subject to contamination from soldering fluxes and applied heat for soldering, and from polishing and buffing dirt derived from the surface finishing of the final sections added to the article. Besides the variety of metals present then, we have a multitude of metal films and metallic and non-metallic dirts.

While conceivably the basis metal for hollow-ware might be of almost any workable alloy or element, essentially, in the silver-ware industry, the predominance lies in nickel silver, copper, brass, Britannia metal or alloys of tin, lead or antimony. These may be joined together with soft solders of lead and tin or with the higher melting brass solders and silver solders.

In the polishing operations, details of which will not be dealt with in this article, sand and mineral oil or lard oil may be used, followed by diverse polishing materials containing perhaps, besides the abrasive, lard oil, stearic acid, tallow, petrolatum, and possibly other oils, greases, fats, or waxes, all of which, of course, leave residues that must be removed before plating. It is common practice to

wash at certain stages, such as after sand buffing, not only to remove all harsh abrasive which might mar any subsequent better finish, but also to remove undesirable grease films while convenient to do so. Thus, assume an article, which in its final form consists of a nickel-silver dish mounted on legs cast from a lead tin alloy. If the dish is polished prior to soldering of the legs it may be advantageously washed in fairly strong alkali, to which nickelsilver is appreciably corrosion and tarnish resistant. If washing is delayed until after the lead-tin supports are attached, a much weaker detergent must be employed, with corresponding increase in labor and cost, if not actually ineffectiveness of cleaning, since both lead and tin are extremely sensitive to alkaline solutions, becoming markedly etched therein. By the application of such considerations, it is often possible to greatly economize in cleaning operations in the plating room.

In general, soap washing of most articles at some stage prior to their entering the preplating cycle is desirable. The use of a practically neutral soap will remove a good part of the polishing dirt, if the solution is hot and actively agitated, and yet, due to the absence of free alkali and perhaps the presence of protective colloids, results in no corrosive attack on even the more delicate metals. Sometimes, both to improve detergent action and inhibit tarnish on copper or high copper alloys, ammonia is added to the soap. Ammonium chloride has also been found of assistance in reducing staining. Other additions may be made, such as oleic or even boric acid, to reduce the alkalinity of the soap. The latter is often of a sodium oleate base. One manufacturer blends with it an organic solvent, the result being very efficacious indeed. The actual period of washing depends, of course, on the requirements and washing conditions, but it may be pointed out that often the maximum benefit is derived in a fairly short time and little additional advantage accrues if this time is even greatly extended. On intricate pieces bearing deeply cut patterns, or on pierced work, it may sometimes be impossible to remove all solid dirt without special procedures or equipment.

In recent years, much has been said of solvent liquid or vapor degreasing, or a combination of both. Trichlorethylene is a greatly favored degreaser. Although unquestionably this method is a boon on many occasions, it may not always be of advantage in cleaning hollow-ware. For example, in leaching, by means of the solvent, the oils and greases from the abrasive and solid dirt, the difficulty in removing the latter without individual manual treatment is greatly increased. When the oil or grease is left intact with the abrasive, the latter is removed together with the former if soap-alkali solutions are used, no doubt aided by the formation of soap in situ by the action of the alkali on the grease or oil.

### Alkaline Cleaning

Much has been written on the subject of plating room cleaners and many pages could be devoted to each detail. Such attention is, furthermore, warranted, since preparation before plating is usually of greater importance than the operation of plating itself, and rarely can too much attention and thought be expended in properly preparing the articles. Generally speaking, the alkaline cleaner is relied upon to remove oil or grease films, and difficult soluble soap films or solid dirt that may have been introduced in previous operations. The articles leaving this cleaner should show no "water-breaking", that is, the phenomenon whereby the presence of

visible or invisible foreign matter or films, and thus the absence of a "chemically" clean surface, the water does not wet and spread as a uniform unbroken layer over the metal surface. On the other hand, the absence of any water-break is no guarantee that the surface is absolutely clean. For speediest cleaning, the first cleaner should contain soap or a similar substance, properly supported by a buffered combination of alkaline salts, so that once the optimum alkalinity is established, the detergent solution maintains it.

The soap, of which about one per cent is usually sufficient, should be free-rinsing and should not form insoluble precipitates on the work. For this reason, the newer soap substitutes and wetting agents, such as certain of the sulfonated higher alcohols, are recommended. They not only are free-rinsing, but are not precipitated by hard water or even by solutions of a mildly acidic nature.

As for the alkaline salts, there are numerous combinations possible of, for example, soda ash (sodium carbonate), trisodium phosphate, borax, sodium metasilicate, sodium orthosilicate, sodium hydroxide, etc. There are also, of course, many excellent proprietary alkaline cleaners on the market, designed to meet almost any need. The important point is, however, that the components of the cleaner be so blended that the resulting solution does not attack any of the basis metal and yet cleans well. To eliminate surface etching involves

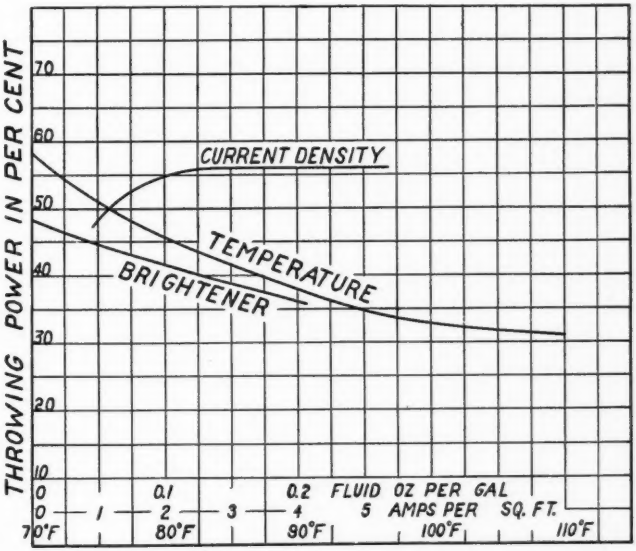


**Fig. 1—Effect of temperature, current density, and brightener on the throwing power of a silver plating solution.**

primarily keeping the sodium hydroxide content as low as possible. It has already been mentioned that whereas nickel-silver is appreciably resistant to alkali attack, alloys high in lead or tin, such as Britannia metal and the soft solders, are easily etched by such solutions. If the hollow-ware being cleaned contains as important component parts of such alloys, the cleaner must be adjusted accordingly. It is possible, also, to have in the solution inhibitors which protect such alloys from alkali attack to some extent. Sodium metasilicate, besides being a good detergent, is useful for this purpose. Copper, though prone to tarnish, is not so readily actually

etched and any tarnish that may form is usually readily removed by immersion in a cyanide, ammonia, or cream of tartar dip.

Besides deciding upon the proper cleaning compound based on the above broad outline, the question also arises as to whether the cleaning should be aided with electric current or not. Although there are many advantages to electric cleaning which have been well stated elsewhere, the authors feel that in dealing with hollow-ware at least, the use of a cathodic cleaning for any appreciable length of time is not desirable. The main reason is that, after the solution has been in use for some time, it inevitably builds up in the white metals such as tin, from these alloy components of the hollow-ware articles which have been even only imperceptibly attacked by the alkali, and these metals, together with certain suspended matter, tend to plate out on the work while it is being cathodically cleaned. Such deposition may lead, eventually, to unsatisfactory results from the plating solution. While it is possible to minimize this effect by reversing the current for some seconds, such a procedure complicates the situation, usually requires additional solutions, and risks the dulling of lustrously polished basis metal. The authors prefer, therefore, to use the first cleaner as a still, soaking cleaner, usually five to ten minutes being sufficient for immersion of the articles. After the first cleaner, the articles should be thoroughly rinsed in warm water to remove all trace, if possible, of soap, and then again rinsed in cold running water.

After such or similar alkaline cleaning, the procedure depends somewhat on the nature of the articles and the efficiency of previous treatments. This is a good stage at which to introduce individual hand operations where necessary to remove last traces of dirt, for at least on elaborate and highly ornamented articles and pierced work such expedients may be necessary as hand swabbing with cleaner solutions, pressure cleaning with live steam, or machine brushing or scouring with brass, steel, hair or cloth wheels and perhaps with abrasives such as lime, tripoli, or pumice. Often, too, especially if the first cleaner has not been correctly compounded, such operations as the above are necessary to remove films of corrosion products from lead, tin, or zinc alloys or to restore a particular finish to such metals as may have become noticeably etched. If abrasives are used, the articles should be well rinsed, or sponged in clear water to remove adhering particles.

It is good practice to use a double alkaline cleaner system, for one reason because the first cleaner takes the brunt of vigorous usage leaving the second in a more desirable condition, and for another reason because the second can be made milder than the first or certain ingredients, such as soap, omitted to facilitate later rinsing and dipping. The time of immersion in the second cleaner is usually fairly short and this fact, together with the fact that the solution itself is less corrosive, removes many objections to the use of current. The second cleaner can, in general, be regarded as an additional precaution against incompleteness of action in the first cleaner, and as a means of removing stains due to intermediate handling and undesirable films that may have been deposited in the first harsher and more severely worked detergent solution.

### Dips

Rinsing after the second cleaner is now automatically more simple, since only weak and diluted alkalies are present on the work. The rinsing should nevertheless be thorough. To neutralize any alkali still remaining,

and to dissolve any oxide films that may have been formed, an acid dip is next introduced. Either weak sulfuric or muriatic acid may be employed.

A favorite practice at this stage is to add to the muriatic acid dip a fraction of an ounce of mercuric chloride per gallon of solution, for the benefit of the copper and soft metal alloys, which after immersion are covered with a thin adhering film of metallic mercury. Such a film is considered an aid in later "strike" plating, offsetting the tendency for the silver to deposit by immersion and non-uniformly, as described below. If the strike solution and the striking technique are correct, however, it is possible at times to omit this procedure, which is often desirable, since the presence of the mercury may increase the tendency for articles to be stained, may require more careful rinsing, and may ultimately develop a cloudy silver deposit.

Following the acid dip is the usual thorough cold water rinse. The article may still, however, hold a diluted acid film on its surface, and may have slightly tarnished even from exposure to air or unclean water, since the freshly cleaned metal surface is chemically quite active. For these reasons and the one noted later, a cyanide dip is finally employed, containing eight to ten ounces per gallon sodium cyanide. Articles emerging from this dip should be completely clean, and after rinsing, ready for strike-plating, and furthermore can carry into the strike-plating solutions as adhering films at most diluted cyanide which is desirable, and not any foreign solutions.

### Strike Plating

Since silver is such a noble metal, it tends to plate out on baser metals, such as copper, immediately on immersion of the latter and without requiring any electrical inducement. Such a deposit, however, is not sufficiently adherent and should a heavy silver plate be subsequently added to it, the result would be peeling and blistering of the entire silver.

To avoid this, a special plating solution is necessary in which the first "strike" (this is, extremely thin) plate of silver is applied (not by immersion) and after which another solution is used in which to deposit the full plate.

To prevent deposition by immersion, the strike solution should contain very little silver and a high free cyanide content. In general, the silver should not exceed a half troy ounce per gallon of solution, and the free cyanide should be no less than eight ounces per gallon. A few ounces of sodium carbonate per gallon are added to a new solution to improve throwing power. As in all silver cyanide solutions, essentially room temperature is employed for the bath.

The current density in striking should be high, approximately from 15 to 25 amperes per sq. ft., at least for the first few seconds, to further ensure securing an adherent deposit. The variety of metals existing on a single hollow-ware piece again plays a role here, since local battery action is set-up between the dissimilar metals which may actually prevent, or at least hinder, the initial deposition of silver. It is often difficult, for example, to sufficiently cover soft solder seams on nickel silver. There is another reason why the current density in striking must be high, namely, to more than counter-balance the local opposing batteries. Furthermore, striking must be continued until sufficient silver has been deposited to thoroughly and completely cover the entire basis metal. On the other hand, due to the nature of the solution, if striking is prolonged excessively, a very dull, poor plate is obtained which

seriously impairs, if not completely spoils, the final product. During the striking period, the article should be in constant motion. If during striking, gas bubbles adhere to the article, they should be effectively dislodged so that specks on the basis metal are not left unstruck, to give rise later to tiny blisters.

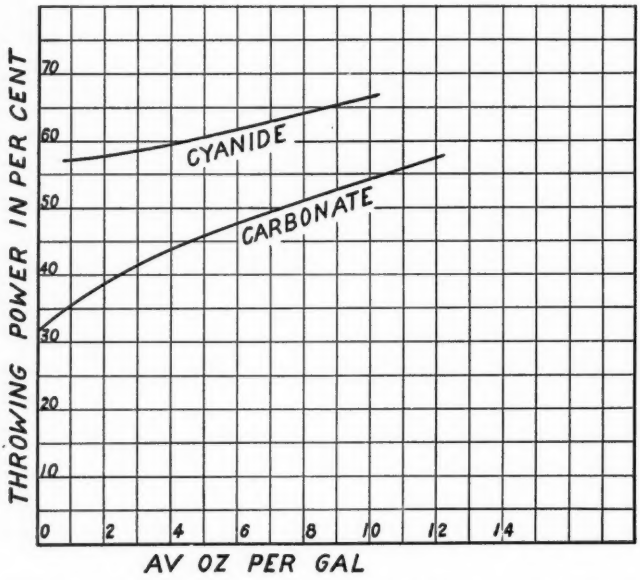


**Fig. 2—Effect of cyanide and carbonate on the throwing power of a silver plating solution.**

Next to cleaning, striking is the most important operation in silver-plating hollow-ware and improper technique existing at this stage is responsible for many a rejected article.

### Plating

After the work has been properly struck, it is transferred directly to the main plating solution. A small, "holding" current should immediately be applied, until the tank has been fully loaded and the correct amperage established. If such a "holding" current is not applied, the solvent action of the free cyanide of the plating solution may lay bare the basis metal so that when the current finally does pass, a non-adherent or blotchy deposit is secured. If the strike has not effectively covered every part of the article this danger of redissolving the silver is enhanced, due to the local battery action that may be initiated between the dissimilar metals as described above. Instances are known where poorly struck pieces have lost their thin silver coatings over the soft solder, with the result that, due to electrically insulating films thus formed on the solder, the latter has received no deposit even at the expiration of the required plating interval.

The composition of the main plating bath for hollow-ware is recommended to be:

Silver.....2.5 to 3.0 troy oz. per gal.
Free Potassium Cyanide.....
4 to 5 av. oz. per gal.
Potassium carbonate.....
about 6 av. oz. per gal.
Carbon disulfide.....as needed

In the course of continued use, part of the cyanide is converted, even by the action of the carbon dioxide in the air, to carbonate, so that the carbonate content of the bath steadily increases until a point is reached

where the drag-out just equals the production of new material. Since the drag-out in plating hollow-ware is relatively high, the concentration of carbonate rarely reaches a value that is really objectionable, especially in potassium solutions, as will be explained below. If in sodium solutions, the value of carbonate becomes too great, a certain amount may be "frozen out" on a cold winter's day, but this method, though perhaps the best and safest available, is nevertheless poor. The ideal way would be to control the carbonate where necessary by precipitation with barium cyanide, but the latter substance is not obtainable in the market.

The question of using potassium or sodium salts in making up and replenishing solutions is still being debated. In the author's experience, supported by many other large plating establishments, potassium platin solutions are preferable for several reasons. Primarily, the deposit itself has been found to be brighter and of a more acceptable physical nature. In the second place, the allowable cathode polarization is higher and since this is increased by increasing carbonate content, the latter may be higher in potassium solutions than in sodium solutions, a decidedly important advantage. For similar reasons higher current densities are permissible before "burning" of the deposit commences, and this, besides economizing in time and therefore money, improves the throwing power. It is felt that these advantages more than offset the greater cost of potassium cyanide.

Silver as ordinarily plated from a cyanide-carbonate solution has a white matt appearance. To facilitate polishing, it is desirable to brighten this deposit. Although many substances have been suggested as additions to the solution for this purpose, the one by far in greater favor is carbon disulfide. Since the solubility of this material in aqueous solutions is very small, common practice is to shake it well with either a portion of the plating solution or a strong cyanide solution, and then to allow it to stand for several weeks, with occasional intermediate shaking. The excess undissolved carbon disulfide settles to the bottom and the clear supernatant liquid is used as the brightener. The exact amount to be added to the plating solution cannot be specified, which is one of the unfortunate characteristics of this brightener, but must be determined by experience and adjusted to the amount of work being plated. Very generally speaking, a concentration of a few tenths of a fluid ounce of brightener per gallon of plating solution is of the correct order of magnitude. The brightener is being continually dissipated, however, due to drag-out, volatilization and decomposition, and it is important that additions of it be made at least daily. Usually, too, its action is not immediate, and becomes apparent only after "working" the bath for a while. An optimum value exists for the concentration of brightener, and great excesses beyond this value have been known to markedly and adversely affect the appearance of the deposit. Other effects of it will be apparent from the summary to be given below.

One of the important problems encountered in plating hollow-ware deals of course with the racking and permissible current density, these being inter-dependent. It is not possible in a discussion such as this to describe racks in detail. Suffice it to say that in many cases silver-plated copper wire simplifies the problem of racking considerably; that if rigid racks are used proper consideration must be given to prevent "thieving" and shielding certain parts, especially hol-

lows, and thus reducing the thickness of deposit in these regions; that the question of properly and conveniently draining the hollow articles must be kept in mind; and that a revision of racking methods to present a more uniformly solid front to the anodes and eliminating as far as practical prominent projections from this front, will often make possible a considerable increase in current density with its associated economies. The current density in plating hollow-ware averages five to seven amperes per sq. ft., but is, of course, affected by many factors, to be summarized below.

Throwing power is naturally of the greatest importance in any plating situation, but assumes particular significance in plating hollow-ware, due to the complex shapes of the pieces involved, and the frequency of protruding legs, handles, spouts, and so on. The throwing power of the bath described above is very good. Its general values can best be shown by the curves in Figs. 1, 2, and 3 which describe its variation with temperature, current density, brightener content, cyanide and carbonate content, and silver content. These values were secured using the well known Haring cell arrangement and a ratio of the distances of the two cathodes from the one anode of 5 to 1. It is evident that besides altering the tank and racking arrangements, the throwing power may be increased by increasing the current density, decreasing the temperature, decreasing the brightener content, decreasing the silver content, increasing the carbonate content or increasing the free cyanide content. Obviously, any of the above changes involves other properties besides throwing power, so that before any particular course is chosen, its influence on everything else must be considered. For example, decreasing the brightener content will increase the throwing power, but perhaps at a considerable sacrifice of the brightness of the deposit. On the other hand, improving throwing power by increasing the current density is particularly desirable since they are mutually beneficial, the improved throwing power permitting an increased current density.

It will be most convenient at this stage and of particular advantage in understanding the influence of most of the factors in silver plating to include here a summary of the effects of the variables involved. This summary is taken from a more detailed paper presented by the authors before The Electrochemical Society (April 1931).

**The Effect of the Silver Content.** An increase in silver content is accompanied by a decrease in resistivity, a decrease in throwing power, an increase in anodic polarization, and a decrease in cathodic polarization. To obtain good deposits, the approximate limits of silver concentration are 1 to 5 troy oz. per gal. depending on the concentration of other constitutents.

**The Effect of Free Cyanide.** An increase in free cyanide is accompanied by a decrease in resistivity, an increase in throwing power, a slight increase in cathodic polarization, and a decrease in anodic polarization. The deposit has a good physical appearance over wide ranges of cyanide content, provided other conditions, such as carbonate content, are properly adjusted.

**The Effect of Carbonate.** An increase in the concentration of carbonate is accompanied by a decrease in resistivity, and increase in throwing power, and an increase in polarization (both anodic and cathodic). The physical appearance is practically unaffected by the concentration and the optimum value of the latter depends on the cyanide content.

**The Effect of $CS_2$.** The addition of brightener has little effect on the resistivity, decreases the throwing power, has little effect on the anode polarization, but decreases the cathode polarization. Up to about 0.2 fl. oz. of saturated solution per gallon (1.5 cc per liter), it brightens the deposit.

**The Effect of Current Density.** An increase in current density is accompanied by an increase in throwing power, an increase in cathode polarization up to the gassing point (at which point the cathode polarization begins to decrease), and a brighter plate up to a certain point. The maximum current density to secure good deposits at 70 deg. F. (21 deg. C.) cannot be fixed. Experiments performed to determine the distribution of deposit in special cases have indicated that on certain parts of the cathode, the effective current density must have been 30 to 40 amperes per sq. ft. (3.4 to 4.3 amp. per sq. dm.) and yet the deposit in these regions is not "burnt". The maximum allowable current density without burning is therefore dependent upon the method of racking and the shape of the articles.

**The Effect of Temperature.** An increase in temperature of the bath is accompanied by a decrease in resistivity, a decrease in throwing power, and a decrease in polarization both at the anode and the cathode. The maximum current density which may be used without burning the deposit is thereby increased. Such an increase is desirable from a plating time consideration and also serves to increase the throwing power sufficiently to overcome its decrease due to increased temperature as mentioned above. From an industrial standpoint, the production can be increased 50 percent by increasing the temperature from 70 deg. F. to 90 deg. F. (21 deg. to 32 deg. C.) without any injurious effects to the plate. This has been actually checked in practice.

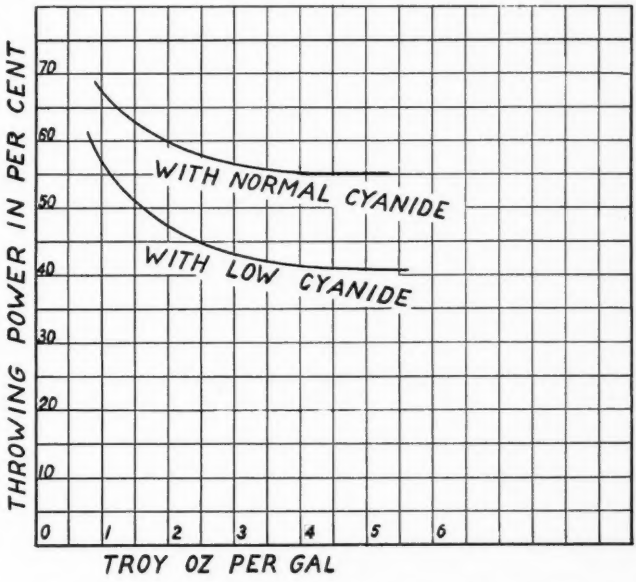


**Fig. 3—Effect of the silver content on the throwing power of a silver bath.**

### Rinsing After Plating and Reclaiming the Silver

After silver plating, some attention must still be given the articles before they leave the plating room, namely,

in the rinsing, since we are dealing with a precious metal. Care should be taken that cupped pieces are emptied back into the plating solution, and a reasonable time allowed for proper drainage. Two cold water stagnant rinses should then be employed, followed by a clean, running, hot water rinse, after which the silver dries readily.

The two cold water rinses are preferably connected to a large stoneware tank and should be drained into the latter at frequent intervals, depending upon how rapidly they accumulate silver. They should not be allowed to acquire too high a concentration since then the drag-out into the hot water may be appreciable.

The large stoneware settling tank is preferably installed in the open air in a secluded region, so that the poisonous fumes of hydrocyanic acid later produced can be safely dispelled. When sufficient volume of solution has been accumulated, muriatic acid is cautiously added, the operator preferably wearing a gas mask to prevent inhalation of the poisonous fumes, until the thoroughly stirred solution reacts acid when tested with blue litmus paper. Savings in acid can be effected by using the acid of degenerate dips, any type of acid being satisfactory as long as it is not used in excess. More safely, therefore, acidification is made with muriatic to prevent accidental dissolution of the precipitated silver cyanide, th chloride of the muriatic acid itself acting as an effective precipitant.

When all the silver has been converted to either the insoluble cyanide or chloride, the valuable sludge is allowed to settle and in due time the clear supernatant liquid is drawn off and discarded. The tank is then ready to receive further rinse waters, unless the accumulation of sludge is so great as to warrant its immediate removal from the tank and shipment to the refiners.

**Advance Buffing Wheel Rakes.** A 4-page folder illustrating and describing the Advance buffing wheel rakes has been issued by the Advance Polishing Wheels, Inc., 844 W. 49th Place, Chicago, Ill., manufacturers of polishing wheels, buffing wheels, and wheel rakes. It is well known by those engaged in metal finishing, that a buff or correct diameter will produce far more work with better results than can be obtained if the buff has worn down. Therefore it is important that it be kept the original size as long as possible, with an even face or "fluff" on the periphery. The Advance wheel rake is said to keep buffs at their best for the longest possible time, for unlike home-made make-shifts of wood and nails, it cannot tear the buff, but rakes it evenly and safely to the correct depth of 3/16 inch.

Advance wheel rakes are safe tools to use. The man's size handles, pinned to the sockets, give a security that is unshaken on the highest speeding wheel. A home-made rake, usually a row of uneven nails driven through a barrel stave or other piece of wood, is unsafe for the operator. Even though the workman may escape injury the buffing wheel will not because the irregularity of the nails plays havoc on the expensive buff. Large automobile manufacturers have adopted the Advance tool as a safety measure. The Advance wheel rake is one of the best means for keeping buffing wheels in the best condition. A copy of this folder free upon request.

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**Ideal Industrial Machinery Catalog No. 36.** This attractive 16-page catalog describing and illustrating Ideal Industrial Machinery for tumbling, separating, cleaning, washing, burnishing, plating, and pickling is now being issued by N. Ransohoff, Inc., West 71st St., at Millcreek, Carthage, Cincinnati, Ohio. Ideal units are presented in this catalog in order to show something of the mechanics of the Ideal system. Ideal equipment is made for washing parts, air drying, saw dust drying, rinsing, dipping, painting, plating, burnishing, and pickling. Copy of catalog No. 36 sent free upon request.

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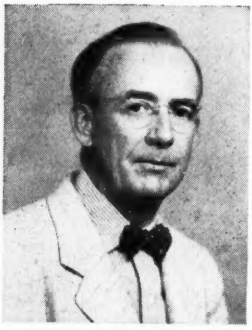

E. V. D. Wallace

# Vapor-Phase Degreasing

As told to Edwin Smith
By E. V. D. Wallace
Pres. Mechanical Process Corp.,
South Orange, New Jersey

THE use of Vapor-Phase Degreasing for removing oil and grease has spread throughout the industry with extraordinary rapidity since the introduction of the process into this country in 1928. So rapid has been the advance that one or two ideas inherited from an earlier day have not been entirely dispelled.

There are some who still look upon the process as a cure-all for all cleaning troubles. Such a cure-all, it most emphatically is not. The role of solvent degreasing either in the liquid-phase, the vapor-phase or in various combinations of both phases, is to remove oil and grease. Removal of dirt and insoluble particles is only incidental to the flow of solvent over the surface of the parts and is rarely or never complete. Oxidation products, if present, are not removed. It is a very exceptional situation in which solvent degreasing alone is sufficient. After the removal of oil and grease, a second operation, such as an electrolytic alkali bath is required to completely clean the parts.

Another idea current in the industry is that the Vapor-Degreasing method is unsuited to parts of light weight because they reach the temperature of the vapor so rapidly that there is no time for sufficient solvent to condense on the surface and thus dissolve the oil. This can best be discussed in connection with a short review of the development of solvent degreasing from the early method of dipping parts in a tank of liquid solvent up to the latest method of suspending parts in hot saturated solvent vapor.

The early solvent degreasers were merely open tanks containing solvent. Oily parts were dipped into the solvent by hand or by mechanical means. During this procedure oil and grease were dissolved but when the parts were removed, a film of oil-contaminated solvent still remained on them. A second or a third tank reduced the contamination, nevertheless, after the first lot of parts had been run through the solutions, the solvent contained a certain amount of oil. One might think of this process as being in the "bath tub" stage.

It was soon found that the liquid

*NOTE: Mr. Wallace is President of the Mechanical Process Corporation, South Orange, N. J. and according to his own statement was responsible for the initial introduction and development of solvent degreasing, particularly the vapor-degreasing process, in this country. He was formerly associated with the Carrier Engineering Corporation, Newark, N. J. He left them when they gave up the degreasing department and started in business for himself. He has been looking on vapor-degreasing as a hobby rather than a business.

solvent dissolved oil much faster when warm. Warming also caused the solvent to evaporate, so, to save solvent, a lid was added to the tank and later a water pipe coil was attached to the under side of the lid. Solvent vapors condensed on the coil and "rained" back into the liquid portion. It did not take long to discover that the parts need not be immersed in the liquid at all, because the clean solvent raining down from the coil dissolved the oil quite completely. The "shower bath" stage had been reached.

Now another difficulty was encountered. To open the tank to load or unload it was necessary to shut off the steam from the heating coils and allow the tank to cool, otherwise much solvent would be lost. The problem was solved by adding a second cooling coil a few inches above the liquid solvent. When water was run through the lower coil, the vapors condensed and the upper part of the tank remained free. This was the stage to which the process had been developed in Europe prior to 1928. In Fig. 1 is shown a drawing of a Crashaw Collender which was used in England and in the Scandinavian countries about this time.

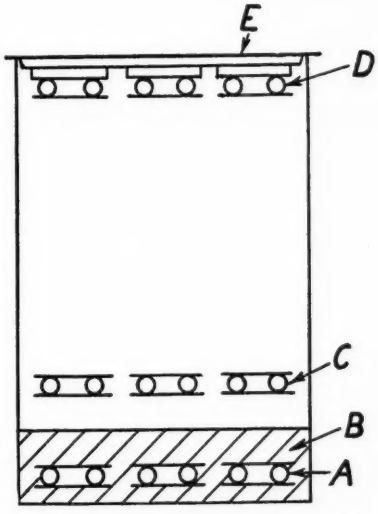


**Fig. 1—Diagram of Crashaw Collender showing the steam coil at A for heating the liquid solvent shown at B. At C is the lower cooling coil and at D is the upper cooling coil. The upper cooling coil is suspended from the lid E. This type was used in Europe prior to 1928.**

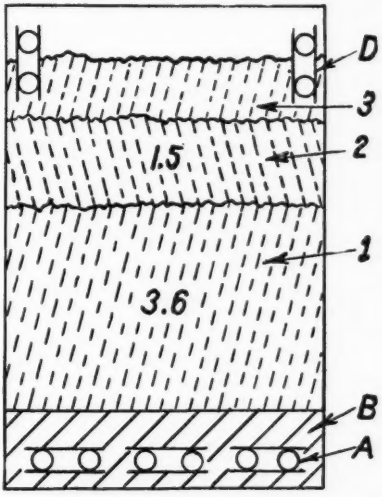


**Fig. 2—Drawing illustrating the first stage in the development of the Crashaw Collender. The lid with the coil and the lower cooling coil has been eliminated and the cooling coil D around the inside of the tank at the top has been substituted. Note particularly the manner in which the solvent vapors stratify inside the tank. (1) Saturated vapor 3.6 times as heavy as air. (2) "Heavy layer" of air and vapor 1.5 times as heavy as air.**

In spite of the improvement over simple dunking in liquid solvent, the shower-bath type had several disadvantages. The lid with the cooling coils suspended from it was cumbersome and in the way when loading and unloading the tank. The lower cooling coil and the steam coil in the solvent made the tank difficult to clean. It was almost impossible to recover small articles which dropped into the liquid, and some of the de-

greased parts were often found badly streaked.

Improvement of the Crashaw Collender to overcome objections of American manufacturers began in

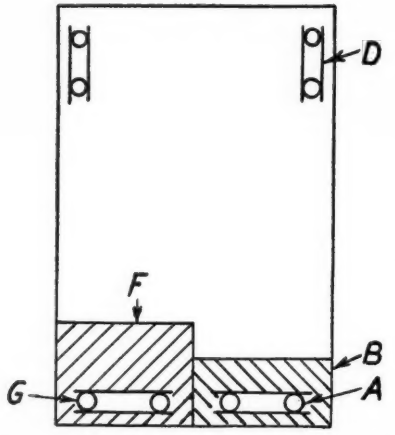


**Fig. 3—The dunking pot shown at F has been added to remove a greater part of the oil and grease than could be accomplished by vapor alone. A cooling coil shown at G keeps the metal parts cool until they are drawn up into the vapor-phase. At B is shown the solvent and at A the heating coil. The arrangement of the cooling coil D is the same as shown in Fig. 2.**

this country in the autumn of 1928. A cooling coil, circling the inside of the top of the tank was added to supplement the condensing action of the coil attached to the lid. One day during the course of some experiment the lid was opened and to the astonishment of the operators solvent vapors were found surging around the top of the tank but not coming out into the room. Investigation showed that they had neglected to open the water valve to the lower cooling coil and had failed to shut the steam off from the heating coil. The whole tank was full of vapor. The discovery was thus made which eventually made the process adaptable for continuous operation. It was found that neither the lid nor the lower condensing coil were necessary.

The reason is fairly obvious in the light of later knowledge. To digress a moment, refer to Fig. 2, which shows a tank with steam coil immersed in the liquid and a condensing coil around the inside of the top of the tank. Vapors rising from boiling solvent reach the cooling coil and are condensed. The saturated vapor is heavy, about 3.6 times as heavy as air. Consequently the vapor rising in the center of the tank, instead of continuing to rise, slides down hill, so to speak, to take the place of vapor condensed on the coil. Very little solvent escapes provided the cooling coil has sufficient capacity to condense as much or more solvent per unit of time as is evaporated by the steam coil in the liquid.

There is always a certain amount of mixing of vapor and air in the upper part of the tank. In Fig. 3 is shown the existing situation in an open-top tank after equilibrium has been reached. At the bottom is the liquid phase. Lying above the liquid is a zone of saturated vapor-phase with a specific gravity of 3.6 with reference to air. Above the saturated vapor lies a well defined zone of solvent vapor mixed with air with a specific gravity of about 1.5. Lying on top of the solvent vapor is a layer of vapor mixed with a much greater quantity of air. The relative heights of the three zones depend upon a number of factors, but for any given set of conditions they will be found fairly constant.

It had been supposed that part of the degreasing action in the Crashaw Collender was due partly to the condensation of solvent on the surface of the articles and partly to the shower-bath effect of the solvent condensed on the coils attached to the lid. Now, if the lid and the

over-head coil were to be eliminated, the success of the process would have to depend entirely on the condensation of solvent on the parts. The final stage had been reached. First the bath-tub stage in which the attempt to clean with contaminated solvent was made, next the shower with clean solvent, and finally the turkish bath sweat.

Each of the preceding stages of development had its own peculiar limitations, and now the vapor-phase revealed limitations of its own. It required entirely too much time to condense sufficient solvent to dissolve heavy, thick or gummy oils and greases. And very light metal parts would reach the temperature of the vapor too quickly to condense any appreciable amount of solvent.

The first problem, that of dissolving heavy oils and greases, has been solved by adding one or more dunking pots into which the parts are dipped prior to passing on to the vapor-phase section. The liquid solvent in the pots is maintained at a

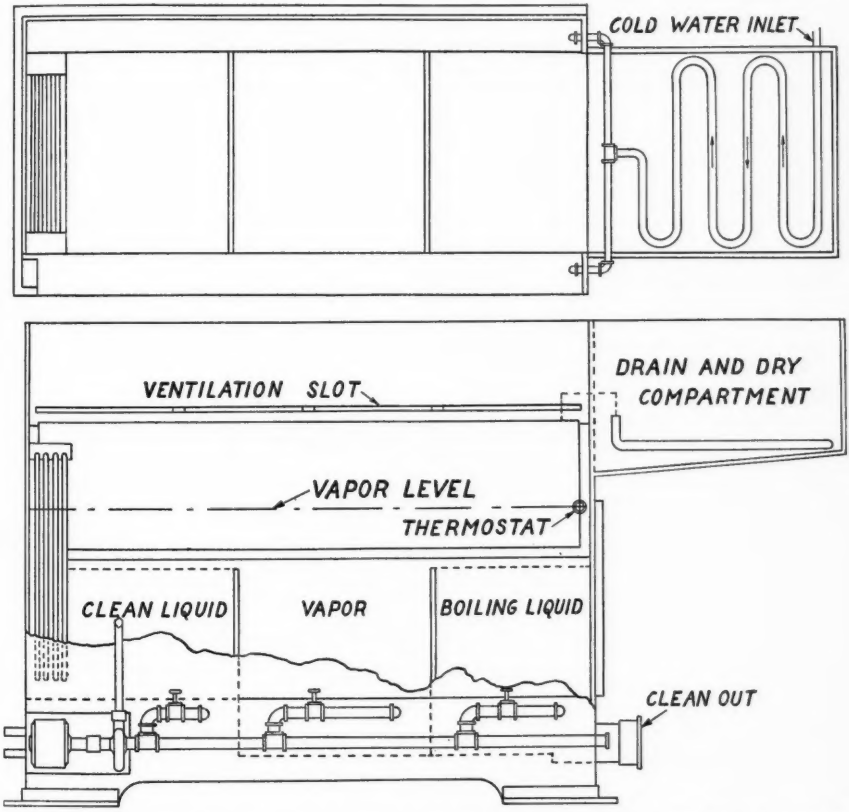


**Fig. 4—One of the modern types of vapor-phase degreasers known as a "Universal D'Oiler". This unit is adaptable for installation in a line of continuous cleaning operations. A ventilation duct is provided to prevent the solvent vapors from escaping into the room.**

temperature considerably below that of the vapor. The major part of the oil is dissolved in the liquid solvent; thus parts withdrawn from the liquid carry only such oil as remains in solution in the solvent. This small amount of oil is then readily eliminated by condensation of vapor on the relatively cool surface.

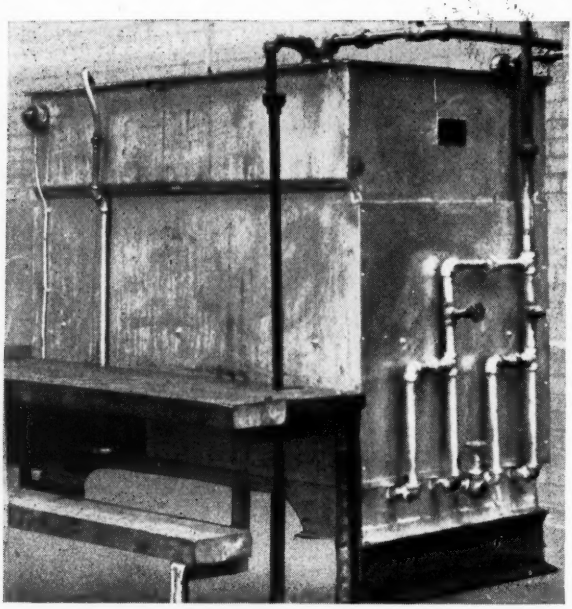

**Fig. 5—A Universal D'Oiler used for a variety of small parts.**

The idea generally prevails that, assuming a most essential part of the process is to have the temperature of the parts which are introduced into the vapor-phase as much below the temperature of the vapor as possible that no more grease will be dissolved after the parts reach the temperature of the vapor. This idea appears to limit the process to parts which are sufficiently heavy to condense all the solvent needed to dissolve the remaining oils before they rise to the temperature of the solvent, at which point no more solvent would be condensed.

What seems to have been overlooked in all the discussion of degreasing in the vapor-phase can be illustrated by a simple experiment. Take an ordinary tin can; dip it in a heavy lubricating oil and suspend it in the vapor-phase without any preliminary dunking. The light metal comes to the temperature of the vapor almost immediately, far too quickly for any amount of solvent to be condensed on the surface. However, if we leave the can there for a few minutes, upon withdrawal it will be found that all the oil has disappeared. The oil could not have been dissolved by the small amount of solvent condensed before the can rose to the temperature of the vapor, and the temperature of the vapor is certainly not high enough to evaporate the oil.

If reference is made to a chemistry text-book to the section dealing with the elevation of the boiling points of solvents when materials are dissolved in them, the most probable answer as to what became of the oil on the can is found. Assuming the temperature of the can to be that of the vapor, the oil on the surface will absorb some of the surrounding vapor forming a solution which, at first, may be considered as a solution of a small amount of solvent in a large amount of oil, and as the absorption continues with increasing proportions of solvent to the point where the oil could be considered as

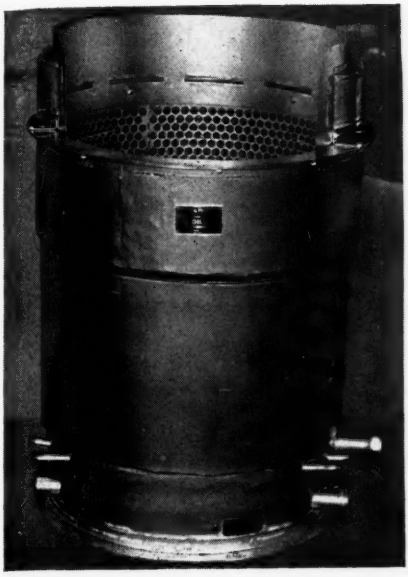

**Fig. 6—Latest type of D'Oiler for hand operation. The unit shown here is not connected for service.**

being dissolved in the solvent.

Two physical properties, the boiling point of the solvent and the viscosity of the oil are changed as the absorbtion of solvent by the oil continues. The boiling point of the solution remains above that of the pure solvent as long as any oil remains. As long as any oil remains it will absorb solvent vapors to form a liquid solution. In other words, as long as there is any oil on the surface of the part a certain amount of solvent will be condensed, assuming of course, that the solvent vapor is not superheated.

The viscosity of the oil or grease on the part will tend to decrease as the part rises to the temperature of the vapor. It will still further decrease as solvent is absorbed, until a point is reached where drops of solution of oil-solvent fall from the part.

The process described in the preceding paragraphs—the absorption of solvent by the oil on the part—is necessarily a slow one. If a second can coated with oil is first dipped in liquid solvent, the final elimination of oil in the vapor-phase will require much less time, but it will never proceed quite so rapidly as would be the case if the can were several times as thick and cool enough at the start to condense some solvent. The time element and not the relative weight of the part in proportion to the surface area is the controlling factor.

Vapor-degreasing is, therefore, not limited to fairly heavy parts but may be used for degreasing all sorts of parts, however light they may be, provided the size and cost of the equipment made necessary by the longer time required to hold the parts in the vapor-phase is not greater than the cost of obtaining the same results in some other manner. This is obviously a question to be decided by detailed analysis of each individual project.

At the outset the statement was

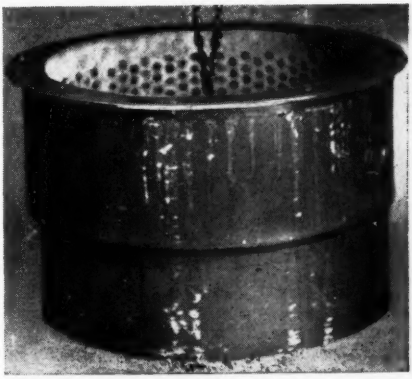

**Fig. 7—One of the smaller types of D'Oilers.**

made that solvent-degreasing was not a cure-all but should be followed by a second step to eliminate dirt

and insoluble particles. Solvent degreasing equipment is not inexpensive; the use of the process adds another step to the cleaning procedure, and so it might be objected to as increasing the cost of cleaning operations over the older methods of aqueous cleaning.

If parts covered with oil and grease must be handled in some continuous manner, aqueous cleaning methods may undoubtedly be developed to accomplish the work. The cycle of operations may require a considerable amount of soaking time, necessitating long tanks, or mechanical scrubbing of some kind. In any event, provision must be made for more or less frequent renewals of cleaning solutions.

The big advantage of the modern solvent degreasing methods is not that it supplants the aqueous steps in the cycle but that by eliminating oil and grease first, it enables the aqueous solutions to complete the removal of dirt and rust so much more efficiently.

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**Hobart Industrial Washing Machine Catalog.** An attractive 32-page catalog, in which Hobart industrial washing machines are presented, is now being issued by the Industrial Washing Machine Division, The Hobart Manufacturing Company, Troy, Ohio. Several standard models are shown, designed so as to be constructed for varying requirements; different widths and types of conveyors, single and multiple units, with or without dryers. Since many cleaning problems require machines of special design, Hobart maintains a staff of designing engineers to work out equipment for the unusually special or difficult cleaning operations. By the laboratory method, accurate analyzation of cleaning requirements are made so as to determine the best type of equipment for solving the specific problem. Hobart industrial washing machines are designed for cleaning parts of materials preparatory to the other operations. Whether the requirement is to remove oils, grease, chips or other foreign substances from the smallest ball bearings to the large engine block castings, Hobart offers equipment for rapidly and economically doing the work. The Hobart machine consists primarily of a large solution tank, a chamber containing the wash or spray system through which the work passes, a pump and motor, equipment for heating the solution, and a conveyor and driving mechanism. Some machines have no conveyor and the work is placed in baskets or racks and manually glided into the machine. Hobart Rotary Drum machines operate on the same general principle as the flat conveyor machines. The work is carried through the wash area by means of a revolving drum of perforated metal equipped with a helical spiral flight conveyor. This is said to insure all surfaces of intricately shaped pieces to exposure of the action of the wash streams. The Industrial Washing Machine Division will send a copy of this catalog free upon request.

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**Dip-Spra Bonderizing.** This attractive 6-page folder is now being issued by Parker Rust-Proof Company, 2177 E. Milwaukee Ave., Detroit, Mich. The advantages of Dip-Spra Bonderizing are described with illustrations and drawings. Three important objectives are said to be attained with the Dip-Spra Bonderizing process; namely, reduction of processing time, reduction of heat requirement, and increase in the range of products processed. The Dip-Spra process combines the rapid coating characteristics of the Spra-Bonderite chemical with the immersion method.

In addition to iron and steel, the Dip-Spra solution reacts on galvanizing, galvanneal, zinc alloy die castings, cadmium plated surfaces, and produces a corrosion inhibiting phosphate coating that provides an adherent base for paint, enamel, or lacquer. A copy of this folder in which specifications are also given can be had upon request.

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**Bristol Bulletin No. 482.** The recording round-chart potentiometer known as the Pyromaster, recently announced by The Bristol Company, Waterbury, Conn., is described in their Bulletin No. 482. In this bulletin will be found drilling dimensions, chart lists, and other engineering data pertaining to the Pyromaster in the following forms: pyrometer, tachometer, resistance thermometer, millivoltmeter, and milliammeter. Copy of Bulletin No. 482 will be sent to anyone interested in the subject of measurement by means of the potentiometer system.

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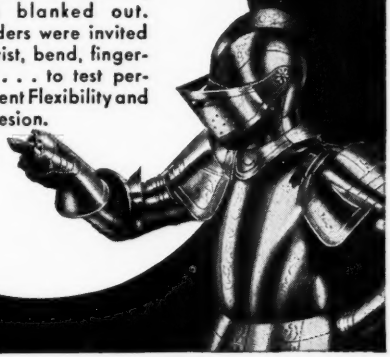

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# Setting Up Specifications on Protective Coatings

By M. H. Corbin

**Research Director, The Arco Company, Cleveland, Ohio**

IN the manufacture of metal products, the finish has become an important factor, both from the standpoint of cost and of the sales appeal of the article. It is a general rule that the quality of an article is roughly determined by the quality of its finish. Most manufacturers know how much they can spend for their finishing process in order to compete in their respective markets.

In selecting a finishing material the first consideration should be what is expected of the material and what quality of paint the unfinished product warrants. Taking this into consideration there are a number of cases where manufacturers of metal products are using a finishing system which is too expensive. Where this is true, a saving could be effected. There are also cases where the manufacturers, in an attempt to cut the cost, have reduced the quality of their finish too low, a practice which eventually affects their sales.

After the quality of finish is decided upon, careful consideration should be given to the various factors which contribute to quality; and upon these specifications should be drawn up. When this procedure is followed one can be sure that the maximum value will be received from his paint purchases. This is brought out clearly in the automotive and refrigerator industries. While setting up such a control may involve some initial expense, it will readily pay for itself many times over.

There are several general properties of paint films with which manufacturers of metal products should concern themselves—properties such as adhesion, flexibility, toughness, hardness, abrasion resistance, permanence, workability, and so on. Besides these there are special properties, the importance of which depends upon the use to which the article is to be subjected. Some of these are durability, washability, and resistance to humidity, fumes, acids, alkalies, moisture, grease, oil, alcohol, solvents, and so on. Many paint laboratories as well as metal products manufacturers have set up various methods of determining these different properties.

In all physical evaluation of paint films, uniform film thickness is important. The Bell Telephone Laboratories obtain uniform films by means of a spray gun that travels at a definite speed. In this way the same amount of paint is applied per coat when similar materials are sprayed on test panels. Quite uniform films can also be obtained by means of spinning. Another method is the use of a "doctor blade" which is drawn over the panel allowing a definite opening for the film between the blade and the test panel. In most cases, however, satisfactory test films can be obtained by uniform and cautious spraying. The thickness of the film should be measured by any of

the conventional methods.

Uniformly cleaned and prepared panels are also necessary to obtain any degree of accuracy for comparative results in the testing of paint films. Special care should be taken that panels are not finger marked after they have been properly cleaned.

Hardness is essential in protective coating films so that the finished article will not be too easily scratched, scraped, or marred. The harder the film, the better the finish, providing that the paint does not reach the point of brittleness. Sometimes hardness is obtained by the sacrifice of flexibility and toughness, in which case a slight impact on the film causes chipping and flaking off. Hardness can be conveniently measured by means of a Pfund Hardness meter, as shown in Fig. 1. This apparatus consists of a spherical quartz lens **B** mounted in the middle of a pivoted arm **A**. At the end of the arm is a weight pan **C** on which a weight **W** is placed. Above the quartz lens is a microscope **E** which magnifies about seventy times. The paint film is applied on a metal panel and allowed to dry for a definite period of time. The film is then placed on a support below the quartz lens, and weights are put on the weight pan until a definite size indentation is made on the film when viewed according to a scale in the eye piece of the microscope. Although there are a number of other methods for the determination of hardness, this procedure is the most generally adopted.

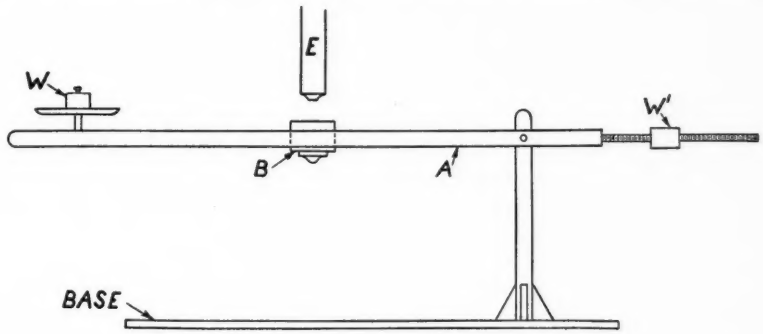


**Fig. 1—Diagram of a Pfund hardness meter.**

Adhesion and flexibility are two factors which are closely related. Films may be very flexible but will appear short when scraped with a knife blade, if they lack adhesion. These two properties are important to insure resistance of the finish to chipping, flaking, and so on. Flexibility, however, should not be striven for to the point at which too great a sacrifice of hardness has to be made.

The properties of adhesion and flexibility are determined by means of an extrusion test, most conveniently made on an Erichsen apparatus. For this test a standard panel is finished with the paint to be tested and dried under uniform conditions. The film thickness must also be uniform. The panel is then sufficiently supported and a steel ball on a worm drive is forced against the panel, thus drawing the metal. The distance the ball travels or the depth to which the metal is drawn before the film is

ruptured is measured on a Vernier scale.

An impact test is also used to a considerable extent to measure these properties. There are various forms of this apparatus. The Bell Telephone Laboratories use a continuous method. A ball on a pivoted arm is rotated on a shaft so that it strikes the paint film. It travels along the film at accelerated speeds. The distance it travels is measured and is used to determine the factor for relative impact test. The greater the velocity of the hammer, the more severe the test. The most simple impact test is that of the falling ball as shown in Fig. 2. The panel **B** to be tested is placed on the base **A**. The carriage **C** to which a steel ball **D** is attached is raised to a definite height. A definite weight **W** is also placed on the carriage. The carriage is released, and thus ball **D** indents **B**. The height and weight required to rupture the film is used to derive the impact factor.

The abrasion resistance of a finish is a rough measure of the wear from constant usage which the article will be able to withstand. This factor is important with objects that are handled considerably, with finishes which require washing with soap powders, or with parts that are exposed to frictional wear. The abrasion resistance of a film is related to the other properties of the film, particularly to the index of hardness and toughness.

Relative values for abrasion resistance can be obtained by allowing abrasive particles to fall on the paint film until it is worn through. There are modifications of this type of equipment, but for practical work the Gardner abrasion tester is satisfactory. A simple design showing the principles of design of a Gardner tester is shown in Fig. 3. Sand or carborundum is allowed to drop a definite distance onto the paint film which is held at a 45 deg. angle. The weight of sand required to wear through the film is used as the measure of relative abrasion resistance. The film thickness must also be taken into consideration.

Condensation of atmospheric moisture on metal products causes deterioration of the finish that is not properly formulated to meet such conditions. This causes rusting of the base metal which in turn destroys the adhesion of the film. It also, in some cases, causes pimpling, cracking, and dulling of the finish. There are a number of metal products that are exposed to moist atmospheric conditions. In such cases, a humidity test should be conducted when finishing materials are being selected. There are many types of humidity cabinets in use. The careful control of temperature and humidity is important so as to get good comparative results. Generally a temperature of 110 deg. F. to 120 deg. F. with 100 per cent relative humidity is used. The cabinet should be sufficiently insulated to maintain a uniform condition within. Steam can be generated in the cabinet by heating a small amount of water in the bottom of the cabinet, or it can be introduced by means of small pipes having minute outlets at various locations in the cabinet. Exposure tests are important, in fact, should be required for all objects subjected to outside exposure conditions.

The durability of paint films is a very large question and which can be only briefly alluded to here. Two factors have to be considered, one is the resistance of the pigment to fading, and the other is the resistance of the vehicle to alteration and disintegration. Both factors depend very largely upon the conditions to which the paint is subjected. As regards the influence of exposure, it is obvious in the first place that the life of paints exposed out-of-doors will be very

much shorter than that of paints used on inside work. It is a known fact, however, that the durability of the same paint, under the same apparent conditions of exposure, varies enormously in different localities due to local conditions of climate.

The most informative data can be obtained only from actual exposure tests. However, a relative approximation can be obtained in an accelerated manner by means of a weatherometer. In this apparatus the finish to be tested is put through a cycle of darkness, ultra-violet light, and moisture in an attempt to approximate weather conditions. It takes one hour to make a complete cycle. The accuracy of this test is questionable, but the results in most cases are indicative of the relative value of the different coatings.

When testing color changes alone, the ultra-violet light will give accelerated fading data. These results are also relative, as under actual exposure conditions, different results are obtained on color fading. Southern exposure — on the sea coast — generally produces comparatively quick changes. Paint films that stand up in this type of locality are generally adequate for industrial use.

Acid, alkaline, grease, and fume resistance are tested by having the paint actually come in direct contact with the particular reagent in question. Salt spray tests are sometimes required in specifications. However, there is considerable controversy as to the actual value of such tests as being indicative of the durability of paint films.

The type of experiments used to test the permanence of a coating depends on the nature of the article to be finished. For example, in connection with top enamels the physical tests are the most important, outside of the appearance of the finish. On the other hand, with refrigerator finishes the fume resistance, humidity, grease resistance, and color stability are equally as important as the physical characteristics. Therefore, to set up specifications for paints, the quality of finish to be used must first be determined. The two factors governing the quality are the use to which the article is to be subjected and the maximum cost for finishing which the article will permit.

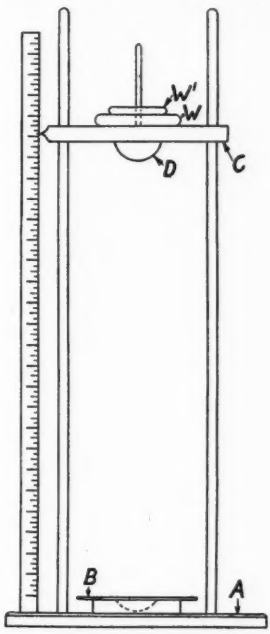


Fig. 2—Diagram of a simple impact tester.

The method of application must next be determined, that is, whether the paint is to be applied by spraying, roller coating, dipping, and so on, and whether it is to be baked, forced dried, or air dried. The production schedule and the size and nature of the article are factors governing the method of application.

The working characteristics of the material must then be studied — for

example, the viscosity of the material and the reduction required to give maximum efficiency of operation and best appearance. The coverage, or the amount of material required to cover a definite area should also be included in the specifications. This insures uniformity in cost of materials. The stability of the materials should also be taken into consideration in order to prevent waste on storage as well as in use, as in dip tanks. Some types of material tend to settle hard, skin on the top, body up or jelly, thus causing unnecessary waste. The solid content of the paint should also be taken into consideration, and if possible a pigment to binder ratio should be established. The drying time should be stipulated so as to insure uniform working schedules.

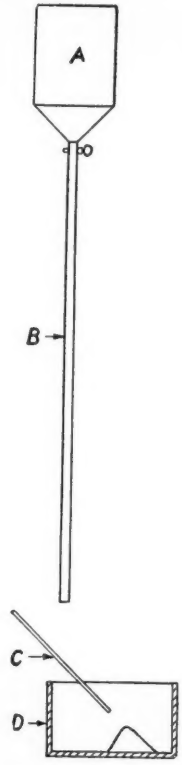


**Fig. 3—Design of an abrasion tester showing the abrasive reservoir at A, the tube through which the abrasive falls at B, the workpiece at C, and the vessel at D into which the abrasive falls.**

Standards should also be set up on the physical properties as outlined above — on adhesion, abrasion resistance, flexibility, hardness, and durability. Special tests should be designed to meet the particular conditions to which the article is to be subjected. If it is to be subjected to outside exposure and humidity, an actual exposure test should be included. Tests for stability of color are also important. Where, for example, we should like to set up the specifications for a painting system for steei kitchen cabinets to compete in a quality maket, upon studying the situation, we find a two coat system is required, a coat of primer baked at 290 deg. F. for one hour, and one coat of finishing material also baked at 290 deg. F. for one hour. To meet the requirements for a high quality finish, we determine that a synthetic system is necessary. Technical recommendation of competent paint manufacturers should be consulted to determine the physical and working constants of the paint material. In the case of kitchen cabinets, humidity resistance is important since moisture condensation is present in a kitchen. Grease resistance is necessary as the housewife will, no doubt, at times handle the doors with greasy fingers. Also some greases which volatilize in cooking will condense on the surfaces of articles in the kitchen. Color stability should also be taken into consideration as sections of the cabinet will at some time be exposed to sunlight, and if the film is susceptible to color changes, light and dark sections of the cabinet will result. Thus, by setting up specifications, uniformity of finish and greater dollar value will result.

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# Corrosion Problems, II

*In this article the author discusses corrosion testing, and such protective coatings and films as paints, varnishes, lacquers, vitreous enamels, and greases.*

By George M. Enos
Asst. Professor of Metallurgy, University of Cincinnati

In selecting a material for use, there are many things to consider. We are not concerned here with the physical and mechanical properties, but only with the selection of a material on the basis of its resistance to corrosion. Assuming that several materials are suitable from the viewpoint of strength and cost, and that the metal is to be used unprotected, or, if originally protected, that the protective coating may fail in service, it becomes important to consider how the material is to be tested for corrosion resistance. Certain principles can be stated to guide in making corrosion tests.

1. There are no short time tests that are entirely reliable for predicting the behavior of a material over a long period of service. Short time tests may be of value to determine whether pitting will be apt to occur, and to obtain a general idea of the behavior of the material under the probable conditions of service. Of course, under drastic conditions of service, a short time test may rule out certain materials from any further consideration, but in general, short time tests do not differentiate sufficiently between materials that each show fair corrosion resistance. By "short time" is meant tests of a few hours or days duration.

2. A large number of samples should be included in every test in order to obtain a fair average in computed results. There is no exact rule to be followed, but a test which includes a dozen samples is more reliable than one which includes only two or three.

3. Each test made, with a large number of samples as indicated above, should as far as possible, have only one variable. This is not always feasible, and in tests extending over years in service it is not so important, but in laboratory testing only one factor should be varied at a time. If, for example, materials are to be tested for corrosion resistance in sulphuric acid, the variable considered might be the concentration of the acid, and all other variables, time, temperature, and so forth, should be kept constant if comparable results are to be obtained. In other tests, other important variations can be considered if desired.

4. If laboratory tests are to be made, the conditions of service that are expected should be duplicated as nearly as possible. Thus, if it is decided to determine the resistance of various materials to flowing river water, the sample should be exposed in moving water of about the same composition, and with no greater temperature variation than would be expected in service. It may be that the material to be used will be alternately exposed to air and to liquid, (for example, pontoons on an airplane) and in such a case, the test should include

alternate exposure to air and dipping in solution.

Too much emphasis cannot be placed on this matter of duplicating service conditions as closely as possible in laboratory tests. A material may be quite resistant when completely immersed in 5 per cent sulphuric acid in a laboratory. This is absolutely no indication of how it will stand up in service under some other conditions.

Duplication of service conditions in a laboratory test includes duplication of the physical condition of the material. While the chemical composition may be the same in both materials, a rolled material may corrode quite differently than would a cast material, under the same conditions.

5. In making corrosion tests the work should be carefully planned, and qualitative changes should be noted. Both loss in weight and pitting characteristics should be measured. It is often desirable to test for changes in physical and mechanical characteristics, as well as for actual weight change, by making tensile tests, or other suitable tests, on corroded samples. This is particularly desirable where pitting has not been excessive and where change in dimensions has not been appreciable. When weight loss is to be measured it is important to remove adhering corrosion products in such a way that the underlying metal is not disturbed, with either chemicals or mechanical means.

The most reliable tests, of course, are those which extend over a long time period and are conducted under service conditions. Tests in river water

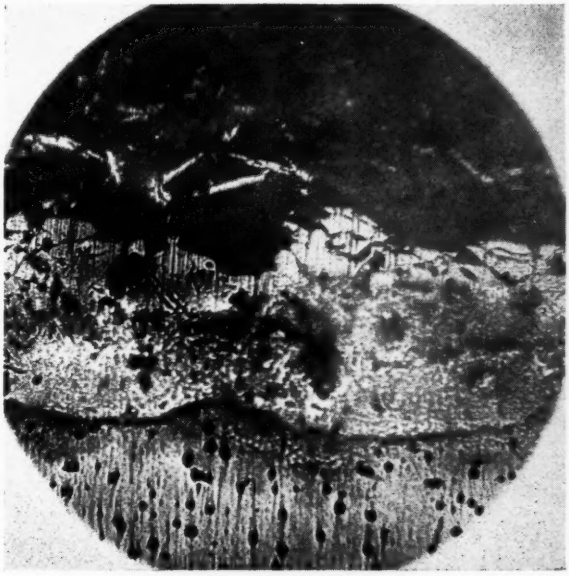

**Fig. 6—Photomicrograph at 300 diameters showing thickness of a coating found on a piece of bronze. The bronze is shown at the bottom and above it is the protecting coat. The material at the top is a material used to protect the specimen while it is sectioned and polished.**

were mentioned. Rather than synthesize river water and expose samples in beakers in the laboratory, it would be preferable to expose a large number of samples in the actual river over a period of months or years, withdrawing samples periodically for examination, cleaning, weighing, and testing, so that the course of corrosion with time could be determined. In this connection long time tests have been conducted by the American Society for Testing Materials and by the United States Bureau of Standards and by the United States Bureau of

Mines on various common structural metals and alloys, as well as by numerous companies. Numerous papers have been published giving their findings.

**Protective Coatings and Films**

So far in this discussion it has been assumed that the metals or alloys would be used in their natural condition, without protection of any extraneous coating. Attempts to combat or retard corrosion have followed many paths, but most of these can be summed up as follows:

1. A metal or alloy is selected for use on the basis that its corrosion rate will be low under the conditions of service and that synthetic protective coatings either are unnecesary, or are undesirable for some reason. Wrought iron pipe in general gives excellent service for carrying ordinary water, and a protective coating is **unnecessary** on the water side. Naval brass is used in condenser tubes in marine boilers. Here a protective coating would be **undesirable,** because it would either deteriorate, or would lower the rate of heat transfer, or both. Numerous other examples of the use of unprotected metal could be cited.

2. The second general method of retarding or preventing corrosion is to protect a material that is suitable for the purpose, (because of strength, cost, or other reasons) by means of a suitable coating. These coatings are well known, but some brief discussion of the types of coatings used is in order.

**Paints, varnishes, lacquers.** This is probably the most general method of protecting against corrosion. Structural steel is given a paint coating of red lead, even though it may be later encased in concrete, or if exposed, additional coats of paint are given. Steel bridges are periodically repainted as a necessary precaution against corrosion, for a paint coating will, after a certain time, deteriorate and expose the base of steel.

**Metal coatings.** The use of zinc in galvanizing, tin in tin plating, chromium, cadmium, and other metals in electroplating is so common that little need be said except to point out the reasons for choice of any particular metal as a coating. Considering iron or steel as the metal to be protected, all metals above iron in the electromotive force series of metals protect, first, by exclusion of the corroding medium, and second, by assuming the anode relationship with regard to iron. Aluminum, zinc, chromium, and cadmium should protect iron in both ways, whereas, lead, tin, copper, gold and silver protect only as long as the coating is continuous. The methods of application of the metals will not be discussed, but include dipping, spraying, sintering, and electro-plating. The metal surface to which the coating is applied must, of course, be chemically clean, that is, free from rust.

**Glass, porcelain, vitreous enamels.** These protect by excluding the corroding medium.

**Greases** and related products, exclude the corroding medium temporarily, but cannot be depended upon for long time protection. The coatings which have just been discussed are appreciable in thickness. Their efficiency as protective coatings can be determined in various ways. For example: cadmium plate (and other plates for that matter) may be subjected to a salt spray test.

This test consists in subjecting samples to a spray of salt water for a specified number of hours, (usually 100 or more). The salt water is atomized through a suitable device, and the box in which the sample is placed, the racks, and the atomizer are all constructed of noncorrodible material. The spray is baffled so that it does not impinge directly on the samples. After the required time the samples

# Electro-Chemical Descaling of Metals

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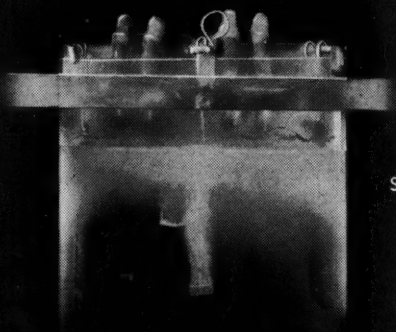

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are examined for evidence of pits, rust spots, etc. This test is sometimes used as a corrosion test on unprotected metals, and for metals to be used in marine service may be of considerable value.

There are other tests, such as examination of properly mounted cross sections of the plated material under the microscope, and the ferroxyl test for pits in tin plate, which are often of value in determining the characteristics of the protective plate.

In the discussion of protective coatings note was made that they are of appreciable thickness, that is, they can be readily measured. Such coatings are usually applied by conventional methods. However, metals which resist many kinds of corrosive attack, such as chromium plate, and stainless steels, are believed to owe their corrosion resistance to the development of a protective film by the metal itself. This film is too thin to be measured by usual methods, but its existence has been proved. Thus chromium due to its position in the e.m.f. series should corrode easily. Its initial corrosion rate is probably high, but the corrosion product, when still only a few atoms thick, and too thin to interfere with the lustrous appearance of the metal, becomes a tightly adherent and continuous film which protects the underlying metal from further attack until it is removed by abrasion or some special chemical attack. In a like manner aluminum forms an oxide film, and the anodizing treatment given aluminum merely produces a thicker, more uniform layer of oxide than would be developed by the metal itself.

The corrosion product formed by metals themselves, then, often acts as a protective coating. In the cases mentioned, this coating is very thin. In some other metals the coating developed by the metal may be quite thick and fairly efficient in retarding some kinds of corrosive attack, such as the patinas developed on bronzes, as shown in Fig. 6. The most important structural metal, iron, unfortunately does not develop a tightly adherent and continuous corrosion product under ordinary corrosion conditions. Rust is generally floculent and easily removed, or if it remains on the metal it acts as a sponge to hold moisture against the metal. However, even iron can be made to develop a fairly good protective coating by special treatments such as "bluing", "parkerizing", and by some other treatments.

No attempt has been made in this article to develop many other interesting features of corrosion processes. With respect to cell action there is a great deal of interest in theoretical and practical electrochemistry. Little has been said about the relationship between microstructure and tendency to corrode, and many other important topics have been omitted. Every problem in corrosion has to be considered separately and a solution found, just as in crime every problem presents its special features which require consideration. In dealing with corrosion, prevention is just as important as crime prevention, but when corrosion has occurred, the investigator must consider the problem, find clues, trace the method of attack, and decide on a remedy. In short, those dealing with corrosion must deal with it as police deal with crime, preventing where possible, and solving each problem as it arises.

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**LEWIS-SHEPARD BULLETINS No. 302 AND No. 314.** Methods of handling tin plate and sheets in warehouses, can factories, metal stamping plants, and so forth, on special lift trucks, floor trucks, portable elevators, stackers and special lifting devices are illustrated and described in Bulletin No. 302, now being issued by Lewis-Shepard Company, Watertown, Mass. Circular No. 314 also shows special stacker and high tier lift trucks for handling tin plate and sheets.

# Barrel Burnishing Of Metal Products, II

*Second Article of Series—Factors in the Selection of Burnishing Barrels*

By H. Leroy Beaver

IT would be exceedingly difficult to present in the course of one paper a complete resume of all the reasons why certain types of burnishing barrels should be selected for given burnishing operations. The questions that are stressed, however, are those that have most frequently arisen both from prospective and present burnishing barrel users.

Many times the question has been asked: "Which is the best burnishing barrel?" The answer, of course, is that there is no one "best" burnishing barrel, but there is always the most satisfactory existing type for a particular burnishing process, or operation. Perhaps it can be better stated in this way—that after a careful analysis of all of the parts a manufacturer wishes to finish by the barrel method, certain features of one type of barrel will be more applicable for the major portion of the parts to be burnished, and therefore the "best" barrel for the particular case.

As outlined in a previous paper, the two predominating types of burnishing barrels in use in this country are the high and narrow type "A" and the long and narrow type "B" of Baird. At this time, there appear to be but two manufacturers of type "A" barrels and at least eight manufacturers of type "B" barrels. Both of these types are sold by their manufacturers as well as by salesmen who act as sales representatives for the manufacturers through various supply houses, but any single one of these sales representations seldom offers more than one type of burnishing barrel, and of one manufacture.

In many cases, the particular type of barrel handled by a given agency immediately and quite automatically forthwith becomes the "best" barrel for every kind and character of burnishing work. Obviously this cannot be true. This is not said with any inference of either sharp practice on the part of agencies or over-zealousness of salesmen, but solely to the fact that even though barrel burnishing has been sought to be practiced in the United States for a hundred years, the understanding of the subject is meager indeed, and this is sometimes true even among barrel manufacturers themselves. One can see, however, that where a prospective buyer may be approached from but two angles on a type "A" barrel, he will likewise be approached from eight separate angles on a type "B" barrel.

This situation presents difficulties as is herewith illustrated. A type "A" barrel designated as an 8-in. by 24-in. size would indicate a barrel 8 inches in width by 24 inches in diameter. Such a barrel will carry a nominal load of burnishing material of 350 pounds. A type "B" barrel

designated as an 8-in. by 24-in. size would indicate a barrel 24 inches in width and 8 inches in diameter, and such a barrel would carry a normal operating load of burnishing material of 125 pounds. So in designating a barrel it is most important to know whether a type "A" or "B" is indicated, for the dimensions are the same except that they are reversed both as to width and diameter.

Inasmuch as the burnishing process is accomplished by the action of a combination of forces working within the barrel when in operation, and principally by the action of the resultant force bearing against the parts to be burnished while passing through the burnishing mass, the shape, weight, and the resistance to permanent deformation of the parts being burnished must always be taken into consideration when purchasing a burnishing barrel. The safe measure is to adopt a barrel that will exert the maximum of pressure without deforming the parts. If the parts are of fairly heavy gauge material and formed with supporting angles or deep drawn sections, in other words parts that will be readily deformed, the type "A" barrel is always indicated because this type concentrates the maximum of pressure within a small area of width. If the parts are of light gauge or of intricate, delicate, or extended formation, the type "B" barrel is clearly indicated, not only because of the lighter load of burnishing material carried but also because of the distribution of the parts over a greater area of width and hence of lower pressure. While the above may serve as a tentative basis for barrel selection, it does not present an infallible rule, and every case of a barrel installation should be handled as a separate and distinct proposition based exclusively on the kind of parts that the particular manufacturer desires to finish.

Another question often raised is "If parts are of such a character that they cannot be 'mass burnished', that is, indiscriminately mixed with the burnishing materials within the barrel, but are required to be supported in or on racks, what, in such a case, is 'the best' type of barrel?" Type "A" does not readily adapt itself to the racking of parts to be burnished and type "B" only partially so. The better type of barrel for racking work to be burnished would be the type "U", where the upper one-third of the barrel composes the lid. In such a barrel the lid can be lifted, the rack containing the parts placed therein, the burnishing material added, and the work successfully performed. The interior of a type "U" barrel may be fitted with slotted metal plates into which partitions may be inserted so that, in this type of barrel, processes can be very closely controlled by varying the area of the barrel to be used which of course varies the capacity of the barrel as well as the amount of pressure of the resultant force. Where parts must be racked for burnishing and tightly secured to the racking device, that is, where they cannot turn in all directions, the driving mechanism should be such that the barrel may be reversed by the use of a suitable reverse gear, thus presenting every part of the racked work to an equal burnishing pressure. Unfortunately such a barrel is not now available for commercial burnishing work. True, there are several makes of barrels wherein one full panel of the barrel periphery is used as a cover for the opening but barrels of this type do not meet the classification in mind, and furthermore, are used principally as "tumbling barrels" with which we are not at present concerned, for the reason that burnishing and tumbling

are separate and distinct classifications.

That this situation of eight times the sales pressure on type "B" barrels as on type "A" barrels presents a very definite problem is borne out by the fact that, in by far the major portion of cases where we are called into consultation, we find that the "wrong" type of barrel has already been purchased, and the necessity of planning a program of operation that will be the most practical and effective, even though the barrel itself is not the proper or "best" barrel for the work.

Among the type "B" barrels now available, there are at least three different models wherein the barrel may be operated in other than a horizontal position, that is, that the open end of the barrel may be tilted upward and that in this position it would theoretically approximate the action of the conventional oblique tilting type barrel which is invariably fitted with a pear shaped barrel, having a smaller diameter at its mouth than at its base. Practically there is a very marked difference. A barrel with parallel sides and with the same diameter at the mouth as at the base, can never approximate the action secured in a pear shaped barrel, for as the mouth of the barrel is raised from the horizontal position the load of burnishing material rises to completely fill the barrel from side to side. The higher the mouth of the barrel is raised towards the perpendicular position the more retarded is the motion within the barrel burnishing mass, until it approaches a point where all motion of the mass ceases and it lies inert and simply idles with the barrel. When operated as a burnishing barrel and in the horizontal position the type "B" barrel is approved for many applications, but if it is sought to be

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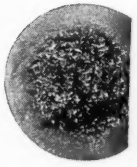

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operated in an effort to even approximate the action of an oblique tilting pear shaped barrel, we cannot subscribe to this theory in any sense. Strictly considered, the oblique tilting type of barrels, while at times used for burnishing work, are more generally considered as "tumbling" barrels, which, as we have previously stated, will be the subject of a later paper.

Now with respect to a machine for burnishing small quantities of a large variety of parts such as we would find in the jewelry trades. The present day tubbing machine or type "T" differs not at all from the original of Barton. There is no question but that it could be immeasurably improved. First the wooden tank or tub should be eliminated and in its stead a half round light weight metal trough substituted. The rack for carrying the separate barrel units might remain substantially the same but preferably made from metal rather than wood. Instead of the perforations in the barrel units to permit ingress and egress of the soapy water lubricant solution, the units should be made water tight and the soap lubricant carried, along with the metallic burnishing material and parts to be burnished all enclosed within the barrel unit. The present method of operation where an entire tub of from twelve to twenty gallons of water must be saponified involves a prolific waste of soap, and still only provides a watery solution, which later burnishing practice proves is not conducive to the best burnishing results. In their present state the tubbing machine or type "T" is headed for obsolescence and to have this happen would be indeed unfortunate. There are a multitude of applications for sectional barrels of this type and it is hoped that some enterprising barrel manufacturer will have the foresight to see the possibilities of exploiting this type but in a modernized form substantially as outlined. In its present state we hesitate to recommend the type "T" machines, but if they are modernized we would commend them to the consideration of the thousands of manufacturers of small parts, where only very small lots are burnished at one time, for in such applications they may be used to splendid advantage.

There is another proposition that must be considered in this connection. Here we are faced with the often asked question: "Is it mechanically possible to barrel burnish this part, or this line of materials?" This question can generally be answered by a simple "yes", because there are few metal parts indeed that cannot be barrel burnished. The real and important question is, however, not whether it is mechanically possible to burnish a particular part or a given line of parts, but the far more important question of whether the operation would be commercially practicable. It should always be borne in mind that, even though many parts are easily mechanically possible to burnish that the operation may be so involved, time required too long or equipment requirements entirely too great to make barrel finishing a profitable or practicable method of finishing. Many times burnishing barrels are sold on the basis of the first noted question of the "mechanical possibility" while forgetting altogether its companion and more important question of "commercial practicability."

In this phase, the element of time must be also considered. To those not completely familiar with barrel burnishing practice this might seem to be comparatively unimportant. Some parts can and may be satisfactorily burnished in twenty minutes while others may require anywhere from eight, twelve and sometimes up to

twenty hours, and the time required to burnish a given quantity of parts has a very important bearing on both quantity and cost of production.

Here, may we offer a pertinent and to us important suggestion to the proposed barrel purchaser to assist him in determining the most satisfactory barrel for his work:

1. Submit a sample of the part or parts you wish to burnish to at least one manufacturer of each type of barrel for a demonstration finish. (Products Finishing will gladly supply the names and addresses of all known barrel manufacturers.)
2. Insist on a definite statement by the manufacturer of how many parts by number or quantity measured either in quarts or pecks can be satisfactorily operated in the type and style of barrel he recommends, in one barrel load.
3. A definite statement of the length of time required to satisfactorily burnish one load of parts with a finish comparable to that of the demonstration sample piece or pieces submitted to the barrel manufacturer and burnished by him and returned to you.
4. A guarantee by the proposed barrel supplier to produce a finish equal to the sample submitted on production lots in your own plant before a sale is considered final or completed.
5. A definite statement by the barrel manufacturer as to just what operation or operations were performed by him on your samples prior to the actual burnishing operation, such as alkaline cleaning, acid dipping, and so on.
6. Space required for installation, h.p. required and does the manufacturer supply any automatic loading device for returning the metallic burnishing materials to the barrel after the completion of the burnishing process.

With the information derived from the answers to the suggested questions you will be able to judge whether barrel finishing will increase your production and cut your costs, and whether it would be a practicable addition to your manufacturing equipment. All of our reputable barrel manufacturers can, and we are sure, will gladly cooperate with you in every way. It is your money you are spending and you have the right to know just what you are to receive for it.

Though there are eight designs of type "B" barrels, if you should seek a barrel for doing a small quantity of work, invariably the smaller size of barrel is recommended. No manufacturers of type "B" barrels has ever, to our knowledge, suggested or advocated the use of a "dummy" or filler so that one-third, one-half or two-thirds of a large barrel could be used variously for small loads, thus somewhat approximating a type "T" barrel, for obtaining lighter pressures and still have the advantage of greater barrel capacity should it be at any time required either for work not at the time in contemplation or where the entire capacity is not immediately required. The first cost of a large barrel is, of course, greater than for a small barrel, but there is surprisingly little difference in the operating cost. A burnishing barrel once in motion acts much as a fly wheel and the greater power required is for starting. Once the barrel is turning over at its normal operating speed, the load requirement falls rapidly. We are specifically speaking of type "B" barrels when we refer to a "dummy" or "filler". These may be simply six, eight or twelve sided galvanized

metal cans made to fit the interior of the barrel and the dimensions for such dummies or fillers should always be taken when the maple liners are swelled to maximum. If no wood liners are used they may be fitted quite closely, but care should be taken in all cases to use burnishing material of such size that it cannot become wedged between the dummy or filler and the sides of the barrel.

Then too, another practical method of approximating the work of a type "T" barrel is to make up sets of smaller barrel cylinders that may be operated within a large size type "B" barrel. For example, four eight sided small filler barrels may be constructed to fit inside of one 12, 30-inch burnishing barrel, and each of these small barrels may contain the proper proportion of materials and work to be burnished and the proper proportion of soapy lubricant, the parts all kept separate in their respective classifications. This would in effect replace the type "T" machines which have always been prodigal in the use of soap.

We have met with a surprisingly large number of applications where burnishing barrels have been purchased and where the decision was made not so much on the applicability of the barrel for the work but the fact that it was desired to install the barrel in a certain available space. This is the worst method by far for barrel selection, and should never be adopted unless it can be determined that the barrel will successfully function on the parts to be burnished. It would be better to select the best barrel for the work even though by so doing it would necessitate the installation in another location in the plant layout.

It is obviously impossible to lay down any hard and fast or definite rule governing the selection of any type or size of burnishing barrel without complete knowledge of what will be required of it. Every case should be determined on its merits and only after a most careful survey and analysis not only of the parts at present in the production program but as well the possibility for further use on other types of work and parts to be subsequently produced.

To the best of our knowledge there has never been a central authority to which manufacturers might turn for aid and guidance in the matter of particular burnishing barrel selection. PRODUCTS FINISHING now determines, through its technical editorial departments, to conduct a service of this kind for its readers, undertaking to supply to them absolutely impartial and unbiased counsel to aid them in selecting not only the proper burnishing barrel or barrels, but such other instrumentalities and accessories as may be required to enable them to secure the ultimate in results in their burnishing work. To this end, a form of questionnaire has been prepared covering practically every phase of barrel burnishing. If you are now operating burnishing barrels or contemplate doing so, you are invited to ask for a copy of this questionnaire. You incur no obligation in answering the questions contained therein and it is our hope that in this way we may be of the most assistance to the greatest numbers.

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**Buffalo Bower Blowers and Exhausters.** A 16-page bulletin is now being issued by the Buffalo Forge Company, 190 Mortimer St., Buffalo, N. Y. The Buffalo mill exhausters described in this bulletin include the standard reversible plate, direct-connected, standard reversible, slow speed, high efficiency, high efficiency direct-connected, and slow speed efficiency. Dust and refuse collectors, slide pattern blast gates, volume fans, volume fans with direct motor drive, steel pressure blowers, baby conoidal fans and experimental exhausters are described and illustrated in detail. Copy free upon request.

**Dumore Hand Grinders.** The Dumore Company, Dept. 187-A, Racine, Wis., announces the second of its catalog series —"Dumore Hand Grinders." This catalog comprises eight pages of description and illustrations in color showing the various types of hand grinders made by this firm and the manner in which they are used to finish small radii and irregular shapes, to lap small holes, for various kinds of grinding, drilling, sanding, polishing and so on. Four different types of hand grinders are presented together with specifications. Included also are illustrations and specifications of the different types and sizes of mounted wheels and abrasive bands that are available for use with these grinders. A copy of this catalog is available upon request.

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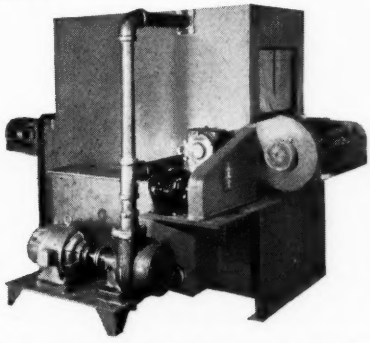
**Manual of Factory Lighting Practice.** Practical solutions of 30 common lighting problems in industry are said to be explained in this 36-page book which is now being issued by Benjamin Electric Mfg. Company, Des Plaines, Ill. The book is intended to provide the plant owner or operating executive with a complete treatise covering the commonly encountered problems of factory lighting and their correct solution. It presents authoritative engineering information on practical, easy-to-apply methods of fitting the lighting to the seeing requirements of each individual operation in the plant. The text discusses 30 common lighting problems found in the various operations and locations in the average plant and gives definite recommendations, installation diagrams, and equipment specifications for the scientific solution of each problem.

The book is written in plain, nontechnical language and is profusely illustrated with drawings showing the relation of the lighting equipment to various seeing problems encountered at the work bench, on the erecting floor or at various types of machines. A page is devoted to each problem with photographs of the different kinds of lighting equipment recommended for the different problems. The answers are given to scores of problems involved in inspection and production operations found in practically any industrial plant. In other words, the book is written for the executive who wants detailed instructions on how to "tailor" his lighting to the seeing needs of his individual operation.

Copies of the book free to plant executives.


**INSPECTION**

Careful inspection is essential if profits are to be maintained. Only thoroughly cleaned parts can be accurately inspected.



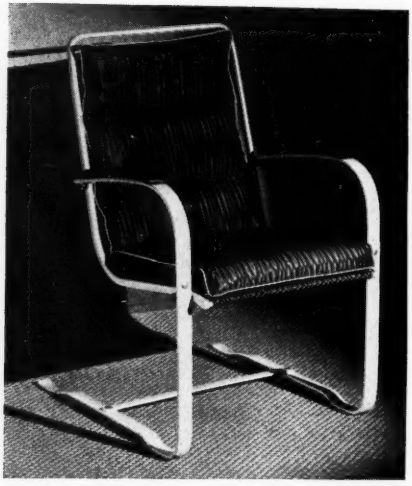
*Where it pays to clean there's a* **HOBART** *machine*

This model 1218-C "Hobart" can be furnished in any of several types and widths of conveyors . . . All Hobart models are readily adaptable to meet particular requirements.

**THE HOBART MANUFACTURING CO.**

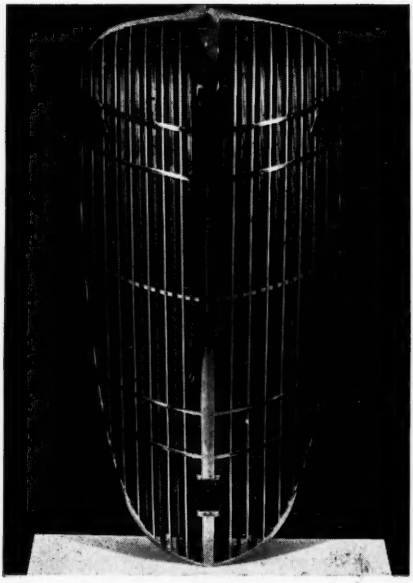
*Industrial Washing Machine Division . . . . Troy, Ohio*

# FINISHES THAT AID IN APPEARANCE AND UTILITY



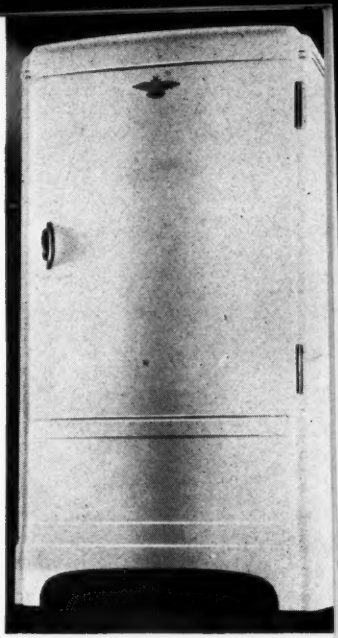
**Left—Simple design and construction together with white enamel finish and chromium plated hardware aid in achieving a rare combination of comfort and beauty in the metal chair shown here.**

*(Photo Courtesy The McKay Company)*

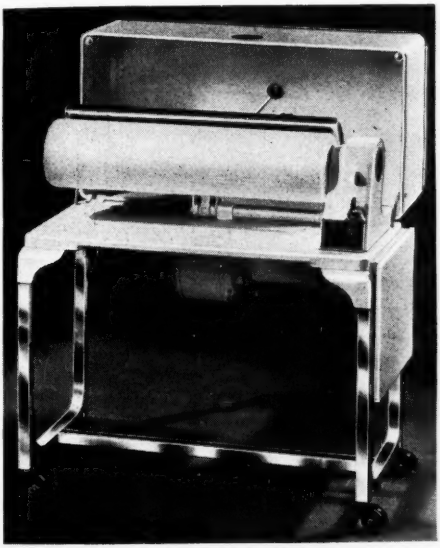


**Right—The use of die castings for radiator shields has been made possible only through the development of successful means of finishing. Chromium plating adds beauty to every fin, thus making the finished grille shown here worthy of its prominent position on the modern automobile. After chrome plating, the grille is dipped into lacquer which covers it completely, but the front surface of each grille is immediately wiped clean, leaving the lacquer only on the sides and back of the fins and presenting a bright surface at the front.**

**Right—Chromium plated strips accentuate the modern, graceful lines of this all-white, lifetime porcelain enamel refrigerator. The interior finish as well as the exterior is highly resistant to ordinary abuse.**



*(Photo Courtesy Frigidaire Division of G. M. S. C.)*

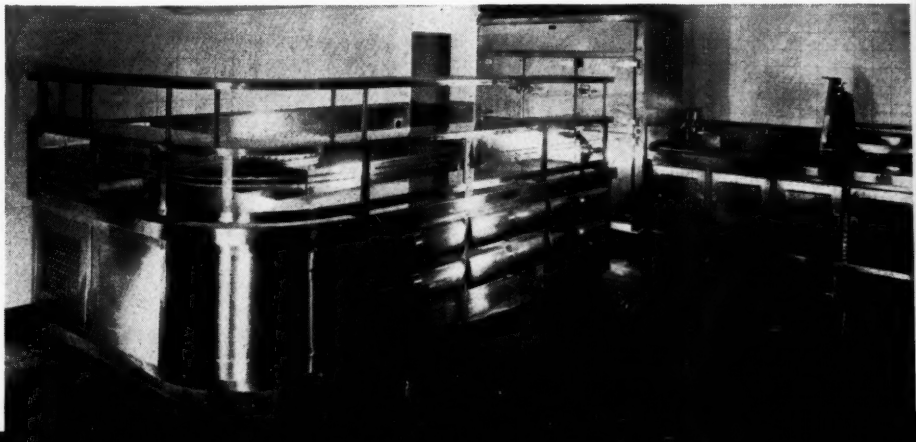


*(Photo Courtesy Conlon Corporation)*

**Left—A cabinet ironer — designed for a discriminating clientele — is presented here in a white enamel cabinet trimmed in black and supported by four tubular chromium plated legs.**

**Below—Tempting foods and shiny stainless steel comprise a combination that is difficult to resist in this cafeteria. Even though the forming qualities of the metal were subjected to a severe test in shaping the intricate contours of the counters and shelves, a lustrous-bright finish was obtained.**

*(Photo Courtesy American Rolling Mill Company)*



# NEWS *of the* INDUSTRY

## Charles L. Jarvis Company At New Location

The Charles L. Jarvis Company, formerly located at Gildersleeve, Conn., manufacturers of Jarvis tapping attachments, power screw drivers, flexible shaft machines, flexible shafts, and rotary files, takes great pride in announcing to all of their customers, prospects and friends that they have moved to their new factory in Middletown, Conn. It is hoped that with considerably increased floor space, better lighting, air conditioning and additional manufacturing equipment their product can be made finer yet and their customers better served.

## Novelty Finishes Discussed by Klinkenstein

The wide variety of attractive novelty finishes now available to manufacturers was described and illustrated in a talk given at the January meeting of the Boston Branch of the American Electro-Platers Society by Gustave Klinkenstein, Vice President and General Manager of Maas & Waldstein Company, lacquer and enamel manufacturers, Newark, N. J.

Mr. Klinkenstein pointed out that the beautiful finishes invented by the ancient masters of lacquering, gilded and glazed china, cloisonne work and so on, can now be reproduced rapidly and economically with modern lacquer finishes. The checked surface of old wood or china can be imitated, Mr. Klinkenstein said, by spraying the product with a coat of colored lacquer enamel followed by a coat of Checklac, a lacquer that cracks open on drying. Another type of lacquer, known as Prismlac, becomes ornamented with crystals when drying, and these crystals grow larger and cover the entire surface.

The brilliant metal colors formed by the anodic and other chemical processes can now be readily reproduced with semi-transparent lacquer called Platelustre. With this lacquer, all known chemical color effects can be reproduced in addition to many new ones.

Other finishes described by Mr. Klinkenstein included mottled pearl, stipple and float finishes, crackly finishes, and webbing lacquers which string out in fine threads when applied.

## International Nickel Company Expands Metallurgical Staff

A. J. Wadhams, Vice President of The International Nickel Company, Inc., 67 Wall St., New York, N. Y., and Manager of the Development and Research Division, has announced several additions to the technical staff.

Charles H. Lindsley, a physical chemist, will specialize in the application of physico-chemical methods to the study of corrosive phenomena. For the past two years, he has been connected with the Biochemical Research Foundation of the Franklin Institute in Philadelphia where he conducted research into the physical chemistry of enzyme reaction. Dr. Lindsley obtained his Ph.D. at Princeton University. He will be located at the research laboratory of the company in Bayonne, N. J.

Donald J. Reese, a foundry engineer, will carry on work on cast iron at the company's research laboratory. Mr. Reese, who was formerly employed by the Whiting Corporation, Harvey, Ill., is well known in foundry circles for his work on cupola operation. He is a graduate of the University of Michigan and holds a degree of B.S. in Chemical Engineering.

Frederick G. Sefing, formerly Assistant Professor of Metallurgy at Michigan State College, will also be employed on research work on cast iron at the Bayonne laboratory. Mr. Sefing is a graduate of Lehigh University in Mechanical Engineering and holds a degree as Master of Science from Pennsylvania State College. He is well known in technical circles largely because of his work on the metallurgy of cast iron.

Richard F. Barnes, Jr., will be available to industry at large for technical service on problems involved in the utilization of mill products such as Monel, Nickel and Inconel for applications requiring resistance to corrosion. After graduation from Massachusetts Institute of Technology with a degree of B.S. in Chemical Engineering, Mr. Barnes was engaged in laboratory studies of paper chemistry and high pressure organic syntheses. During the past three

years, he has been employed on research and production work in the manufacture of organic plastics. He will be available at the New York office.

Carl Rolle will be available to industry for consultation on mill product fabrication problems. Mr. Rolle is a graduate of Pennsylvania State College and holds a Master's degree in Mechanical Engineering from Massachusetts Institute of Technology.

## Porcelain Enamel Institute Annual Meeting

The executive committee of the Porcelain Enamel Institute, 612 N. Michigan Ave., Chicago, Ill., has announced that the seventh annual meeting will be held at Chicago in October. Members of the Institute of Vitreous Enamelers of England will be special guests at this annual meeting. The tentative dates of October 12 to 13 were set.

## DeVilbiss Announces the Schedule of Training School

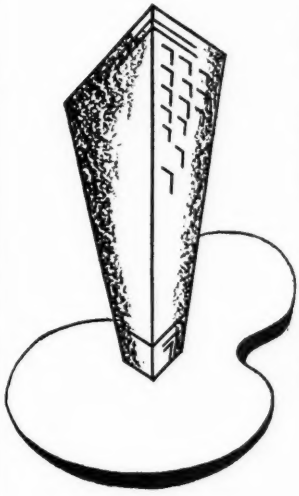
The DeVilbiss Company, 300 Phillips Ave., Toledo, Ohio, has recently announced the schedule of their training school for the first half of 1937. This school is open to industrial painters, master painters, automobile refinishers, and to all those interested in learning the technique of spray painting, the use and the care of spray painting equipment.

The training period lasts for one week. Classes start on the following dates: March 1, April 5, May 3, and June 7. Special rates in Toledo hotels and boarding houses near the plant have been secured by the company for those who wish to attend the school.

Heretofore, the classes have been well attended because of the facilities for study offered by The DeVilbiss Laboratories. It is advisable to enroll in the school as far in advance as possible, since the size of the classes must be limited, and since there will be no training periods other than those announced. Complete information may be obtained by writing The DeVilbiss Company, Toledo, Ohio.

## American Electroplaters' Society To Celebrate Silver Jubilee

The twenty-fifth National Convention of the Electroplating Society is scheduled to be held in June 1937 in New York City.

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E—3980

# UNCLE SAM'S RECEIPTS

*"The Unalterable Proof of a Magazine's Circulation"*

As evidenced by the figures presented below, the total distribution of the February issue of PRODUCTS FINISHING was 12,544 copies. These figures are substantiated by the United States Post Office receipts reproduced at the left, showing a total of 11,774 copies placed in the mail. In addition, 770 copies were sent out with stamps affixed.

# February, 1937 Issue
*of*
# Products Finishing

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| No. 98—TOTAL PIECES (6 1/5 pieces per pound) | 7,248 |
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**Additional information concerning advertising in this publication will be sent upon request.**

**PRODUCTS FINISHING**
431 Main Street Cincinnati, Ohio

# New Plant Equipment and Materials

## Pangborn Electrostatic Precipitator

An electrostatic precipitator for general industrial air cleaning use has been developed by the Pangborn Corporation, Hagerstown, Md. The unit is said to be

Pangborn Electrostatic Precipitator

particularly suitable for salvaging valuable dust, mass air cleaning, or removing objectionable particles from gas or vapor and for similar applications, and is said to have an operating efficiency as high as 99 per cent by weight. Electrical parts are supplied by Westinghouse Electric & Manufacturing Co.

The Pangborn Electrostatic Precipitator is said to have the following advantages: (1) The small size of the unit reduces space requirements and cost, and permits a complete factory assembled unit. (2) The small vacuum tube power pack is attached directly to the precipitator cabinet, eliminating the usual separate room for high voltage generating equipment. (3) Discharged air does not contain appreciable amounts of ozone or oxides of nitrogen and may be breathed without irritation of the membranes. (4) The equipment may be designed for efficiencies as high as 99 per cent by weight and to remove particles as small as one-fifth micron. (5) The machine operates at lower voltages, permitting the use of electronic tubes of standard industrial classification and with low power consumption. (6) The low and constant air flow resistance through the unit results in reduced power and uniform air volume.

The illustration shows a unit which was recently built for a large pottery plant to remove excess glaze dust from the air. In general, the complete unit consists of three parts; collector cells, ionizing assembly, and power pack. These can be furnished assembled in a standard cabinet or as parts for assembly in existing duct work or special cabinets.

## "Synhibit" Process

Thompson & Company, P. O. Box 6757, Pittsburgh, Pa., manufacturers of industrial and technical paints, has announced a new process to be known as "Synhibit" Inhibitor for preserving structural steel, and to provide a rust free surface on which better adhering protective coatings may be applied. The new process consists primarily of a scientific, chemical, and metallurgical pre-treatment of the metal surface.

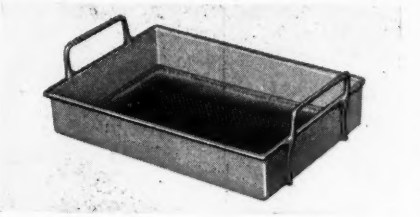
Any loose rust or loose scale on the surface is first removed by wire brushing. That portion of the scale which remains is a protection to the metal surface and aids in the retention of the paint. Wire brushing is followed by a treatment of the wire brushed surfaces with Synhibit, the inhibitor which dissolves and kills the remaining rust and prevents it from forming again. It not only kills surface rust, but also penetrates into the minute cracks in the scale and kills embedded rust so completely that it is impossible for it to grow under the surface of the scale or the protective covering.

In addition, Synhibit Inhibitor forms an ideal surface for the retention of Synhibit synthetic paints, and also insulates and prevents the formation of galvanic electric currents which would start corrosion and destroy the paint film.

The Inhibitor treatment, followed by the application of Synhibit primer which is a zinc chromate, iron oxide synthetic vehicle paint. Synhibit aluminum finish coat is recommended in most cases for the final coating.

## All Welded Dipping Baskets and Trays for Plating

The Udylite Company, 1651 E. Grand Blvd., Detroit, Mich., has announced a complete line of dipping baskets and trays for plating use. Unusual strength, long life, and ability to carry heavy loads without bulging are qualities attributed to all welded construction. It is stated that all welded construction eliminates the possible weakness at points of great stress by the use of cross member reinforcements. Wire or mesh bottom and side cross members are welded to the basket or tray frame, thus forming the parts into one integral.



**Udylite Platers' Tray with Solid Sides and Mesh Bottom**

**Udylite Swivel Bail Type Basket with Reinforced Sides and Bottom**

Udylite dipping baskets in the bail type are furnished with swivel or rigid handles. The trays are furnished with either solid or mesh sides. Both baskets and trays can be furnished made of steel, brass, copper, aluminum, monel metal, and nickel chrome in standard shapes, and various gauges of wire and mesh. Special all welded containers other than standard can be made according to specifications.

Udylite also offers a Duro-Welded reinforced rigid bail type steel basket which is covered with hard or soft rubber having a high resistance to all acids with the exception of concentrated nitric and suplhuric. The Duro-Welded type is furnished in two sizes, the 10x10 in. and the 12x12 in., in ½ in. mesh or larger.

## T. S. T. Triple Safe Tubing

An entirely new development in flexible seamless all-metal hose, to be known as T.S.T. Triple Safe Tubing, has been

**Polish and Buff *Automatically***

**You increase hourly production and cut hourly costs. Large production on shapes, sizes, metals and finishes done at a profit.**

**Act today—write the pioneer builder of Automatic Polishing and Buffing Machines for a production proposal on that "hard to finish" part.**

**THE PACKER MACHINE CO., MERIDEN, CONN.**

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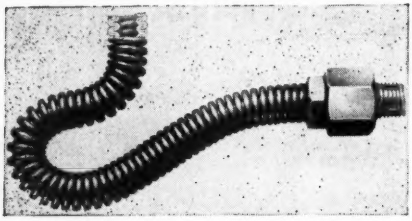
**POLISHING AND BUFFING MACHINES**

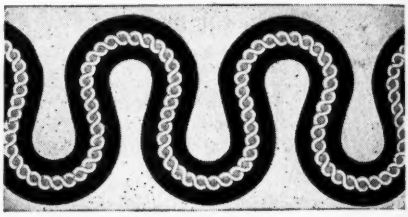


**Standard T.S.T. Triple Safe Tubing**

placed on the market by Seamlex Company, 5-19 48th Ave., Long Island City, N. Y. The tubing is of three-ply, all-metal construction, consisting of an outer layer of seamless bronze tubing, an intermediate thickness of copper braid, and an inner wall of seamless bronze tubing, giving rise to the trade name of "T.S.T."—Triple Safe Tubing. The tubing is intended for use with steam, water, oil, gas, air, gasoline, paint, or practically any other liquid and the manufacturer states that the use of this tubing together with T.S.T. solderless, brazeless, packless fittings eliminates all possibility of leaking joints.

T.S.T. Triple Safe Tubing is made in six sizes, with inside diameters of ¼, 5/16, ⅜, ½, ¾ and 1 in. and with a minimum flexing radius of 6, 8, 10 and 12 in. for the four smaller sizes, the maximum working pressures of which are 500 lbs., 400 lbs., 350 lbs., and 300 lbs. respectively. The minimum flexing radius and maximum working pressures of the two larger sizes are available upon request. One of the outstanding advantages of T.S.T. tubing is that it can be ordered in length of approximately 12 ft. and cut to required length in a few seconds. T.S.T. fitting can be attached by the user in a few minutes.

A sample section of this tubing will be sent free to prospective users upon request.



**Enlarged Cross-Section Drawing Showing Construction of T.S.T. Tubing**

**THE M-B SUPER SPEED AIR GRINDER**

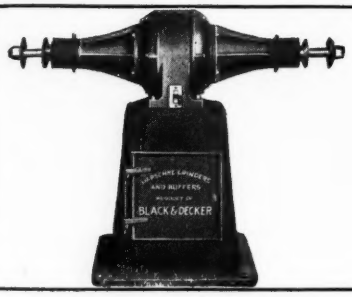
**Has an amazing speed of 100,000 R.P.M. Small-Light-Compact. Just the tool for getting into small, difficult places. Write today for full details and 10 day trial offer.**

**M-B PRODUCTS**

**126 E. Larned St. Detroit, Mich.**


## Efkalin

A heat indicating paint, which has long been a laboratory stunt, has become an industrial reality in "Efkalin," a product of the Efkalin Company, 803 E. 141 St., New York, N. Y. This paint is said to have the property of immediately changing color when exposed to heat, and is applicable to over-heat-prone elements ranging from bearings to pipe lines. Five types are available changing color permanently at temperatures ranging from 300 deg. F. to 734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**Marschke Electric Grinders and Buffers have earned a splendid reputation for safety, long life and high efficiency. Superior materials, design and workmanship give them the strength and rigidity so necessary for your work.**

*Catalog showing machines with 10" to 30" wheels and 1 to 25 H. P. motors sent upon request.*

**Vonnegut Moulder Corp.**

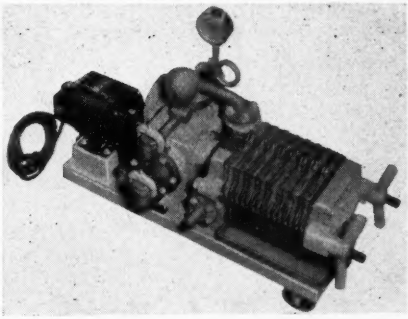
**1811 MADISON AVE. INDIANAPOLIS, IND.**

deg. F., seven retroactive paints change color in ranges from 122 deg. F. to 464 deg. F., returning to original color upon cooling. In such instances, color change is so sharp as to leave no room for doubt that the bearing or pipe is too hot.

## Shriver Filter for Plating Solutions

A small portable filtration unit has been developed by T. Shriver & Company, 814 Hamilton St., Harrison, N. J., which is said to meet the needs of many plating plants for equipment which can handle a nominal quantity of plating solution from small tanks on a continuous basis, or from large tanks on an intermittent basis and insures complete elimination of sediment and contamination from the plating tanks.

The complete outfit consists of a Shriver plate and frame type pressure filter of eight chambers, a Shriver diaphragm pump with strainer which is connected directly to a ¼ h.p. motor, all mounted on a portable stand equipped with roller bearing casters. As an eight chamber filter, the unit will filter up to 90 gal. of plating solutions per hour. The plates, the recessed solid frames of the filter, and all pump parts which come in contact with the fluid are made of hard lead, which is suitable for withstanding the corrosive action of nickel, bright nickel and similar plating solutions.



Shriver Filter for Plating Solutions

The same exposed parts may be made of cast iron, rubber, or other materials which may be more suitable for solutions such as cyanide, acid copper, and so on. The filter is equipped with cotton or wool filter cloths, according to


REVERSIBLE - ADJUSTABLE

"Buffalo" MILL EXHAUSTERS

That's why these better exhaust fans are in such demand in all plants requiring a dependable, economical way to carry off waste materials. Housing easily adjusted for exhausting in any position. Reversing direction of rotation equally simple.

**There are sizes and styles for every exhaust requirement. Write for Bulletin 2678-A.**

**BUFFALO FORGE COMPANY**

**190 Mortimer St. Buffalo, N. Y.**

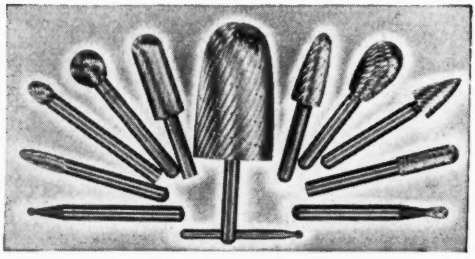
Branch Engineering Offices in Principal Cities
**In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.**

specifications. The portable unit is compact and measures overall 35 in. long, and 16 in. wide. Larger units for greater capacity are also available.

## Severance Milling Cutters

Freehand milling cutters, ground from the solid, for use with flexible shaft equipment and other portable tools are now being manufactured by the Severance Tool Mfg. Co., 1516 East Genessee Ave., Saginaw, Michigan. The cutters are made in a wide variety of designs in standard and special shapes and sizes, to meet every possible need.

Standard designs and sizes are carried in stock; special sizes and shapes are available upon order. The cutters are made from steel of a special analysis, tempered and hardened to give the maximum of cutting life under the most difficult conditions.



**Severance Milling Cutters for use with Flexible Shaft Equipment or Portable Tools**

## Houghton Rust Veto

The E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa., has placed on the market a rust preventative known as "Rust Veto." Rust Veto is said to provide a coating that is impervious to acids, alkalies, fumes, steam, and temperature changes; further, it contains an inhibitor that takes up surface moisture, and thus prevents corrosion from acting within the part protected. Rust Veto is made in numerous grades to meet practically every condition.

## Sterling Speed-Bloc Sander

A new and improved model of the Sterling Speed-Bloc Sander has been announced by the Sterling Products Company, 2457 Woodward Ave., Detroit, Mich. The new model is air driven, and the weight of the sander has been reduced from 7½ to 5½ lbs. This weight reduction and perfected balance, plus the compact dimensions of 7 in. long x 4¾ in. high and 3¾ in. wide provide a comfortable fit to the palm of the hand and make the machine extremely responsive to the guidance of the operator.

The Sterling air motor is of original design and is built to the closest tolerances practiced in the machine tool in-

**NEW SPRAY GUN**

**In the time it takes to adjust old fashioned paint spray equipment, you can write us for specifications and prices of the new Type MM Paint and Lacquer Spray Gun, which cuts both time and operating costs on every job and builds your profits. Bring your shop up-to-date with the new Type MM Spray Gun.**

**THE ALEXANDER MILBURN CO.**
**1436 W. Baltimore St., Baltimore, Md.**

**FINE BRONZE POWDERS AND ALUMINUM PASTE FOR ALL PURPOSES**

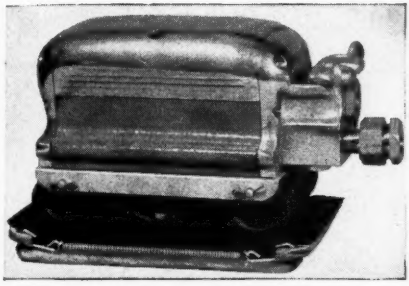
**COLOR CARD AND DESCRIPTIVE MATTER UPON REQUEST**

**CRESCENT BRONZE POWDER COMPANY**
**120 W. Illinois Street Chicago, Ill.**

**Specialists for Metal Finishing Bronzes**

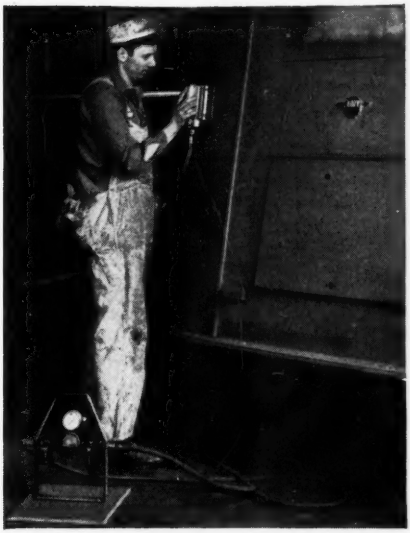
dustry. All parts are interchangeable, which facilitates service. The machine operates efficiently on 45 to 60 lbs. of air pressure, using approximately 6 cu. ft. per minute under load. The cam, flywheel and connecting rod are supported on double shielded ball bearings and all moving parts are manufactured of alloy steel, hardened and ground. Pistons are given an "Anodic" treatment.

For wet work a water connection is provided by which the water hose can be connected to an outlet on either side of the machine which directs a spray of water to the surface being sanded. This manner of designing the water outlet protects the workman from getting wet without the use of baffle plates. For work with naphtha, benzine, and so on, a special block with Sterlite base is provided which is impervious to volatile compounds.



Sterling Speed-Bloc Sander

The principle of "Floating" as applied to the construction of the block and pad is an exclusive feature, providing flexibility for sanding and rubbing of both curved and flat surfaces. Special pads, varying in flexibility, have been developed for particular types of surfaces and materials. The sanding action is reciprocal, with 5/8 in. travel of the pad at speeds of from 1750 to 3000 complete oscillations per minute, depending upon the application. From one to five



Sterling Speed-Bloc Sander in Operation

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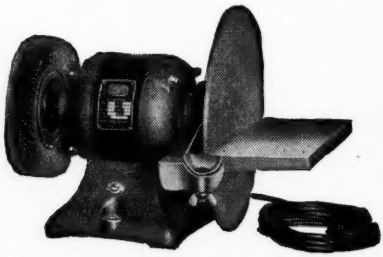
sheets of abrasives may be attached to the pad at one loading. Ordinary size sheets are cut into three pieces without waste, each 3-2/3x9 inches.

## Chelsea 12-In. Disc Grinder and Sander

A complete grinder, sander and buffer of wide construction, free operating facilities, and with accessibility for grinding and sanding large and odd-shaped pieces has been brought out by Chelsea Fan & Blower Company, Inc., 370 West 15th St., New York, N. Y. The machine is equipped with a tool rest and adjustable table which are accurately fitted and properly located. The disc is 12 in. in diameter and is faced with No. 50 Grit Carborundum Aloxite Cloth Disc. An extra threaded shaft is furnished so that a grinding or buffing wheel can be applied to the opposite end. The grinding unit is equipped with a 10 ampere on-and-off switch, 10 ft. of cord and a rubber safety plug.

The grinder is designed for a variety of operations. Wire scratch wheels or cloth buffing wheels can be used when required. The sander is said to be excellent for grinding lathe tool bits at accurate angles. It is also especially adaptable for pattern makers. Power is supplied through a 1/3 h.p., 1750 r.p.m. ball bearing motor. The bearings are well protected to prevent dirt and grit from entering.



**Chelsea 12-In. Disc Grinder and Sander**

## Union-C Series No. 200 Air Compressor

The illustration shows the Union-C Series No. 200 Air Compressor which has been placed on the market by Union-C Machine Co., Inc., Union City, N. J. The 200 Series includes six models designed to deliver from 3 to 26 cu. ft. of free air per minute at a constant pressure of 150 lbs. and an intermittent pressure of 200 lbs. The compressor is built on a double steel cork-insulated base with a cork-insulated motor base. The motor on all models is of the ball bearing type, 50 or 60 cycle, A.C. single phase. The power is transmitted from the motor to the compressor by V-belt drive. Control is provided through an independently fused safety switch.

The compressor is of the plate valve ball bearing type with an intake air cleaner and muffler and automatic pressure control. The tank is electric welded

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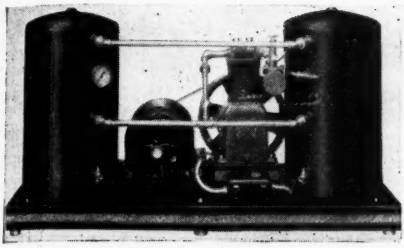

**Union-C Series No. 200 Air Compressor**

and tested to 400 lbs. The dimensions range from 16x44x23 for the ½ h.p. model to 22x70x36 for the 5 h.p. model.

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**ATC Bulletin G-11.** This 4-page bulletin describing and illustrating the ATC Balancer and known as Bulletin G-11 is now being issued by the Automatic Temperature Control Company, 34 E. Logan St., Philadelphia, Pa. The place of the ATC Balancer in the control field is fully explained. Copy free upon request.

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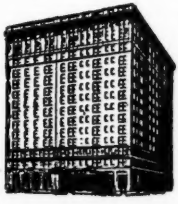

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